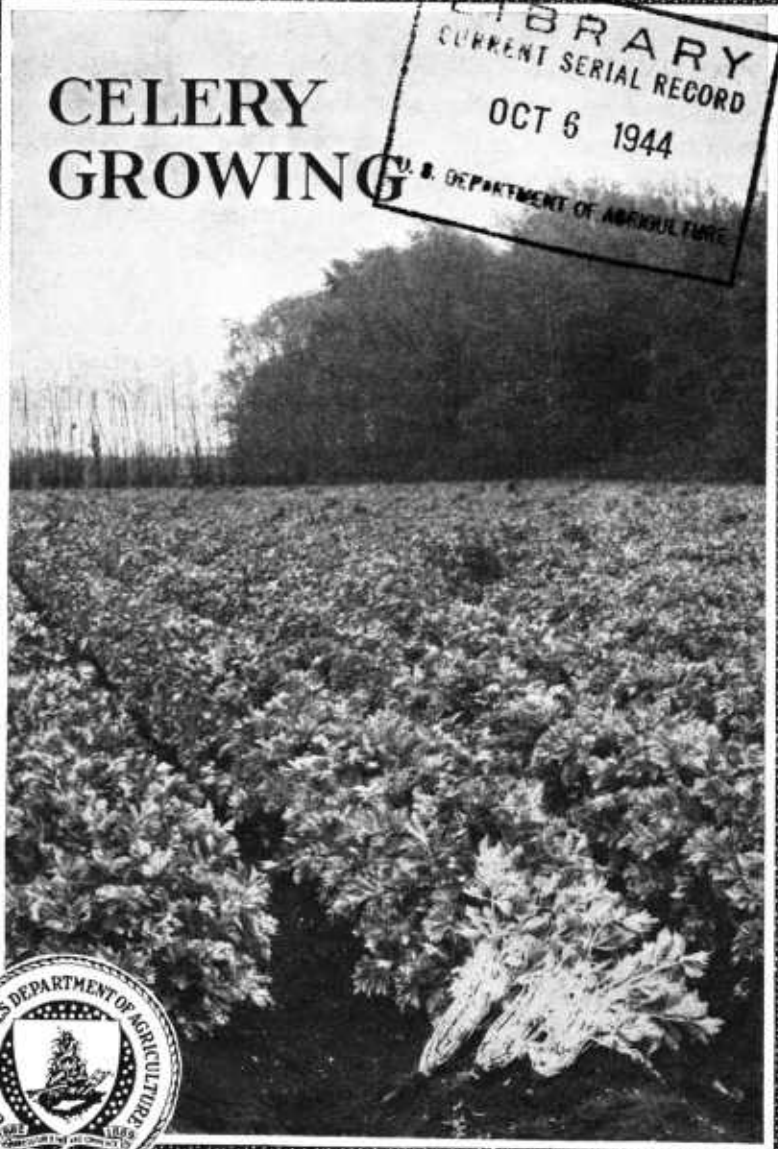
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1269

CELERY GROWING



COMMERCIAL CELERY GROWING in the United States had its beginning at Kalamazoo, Mich., in 1874, but rapid expansion of the industry did not occur until after 1880. The acreage annually devoted to growing the commercial celery crop at present varies between 31,000 and 41,000 acres, and the shipments range between 19,000 and 27,000 cars.

The extension of the celery-growing industry to a number of sections of the country having specially favorable soil and climatic conditions has made possible the production and marketing of a good grade of celery at practically all seasons of the year. This extension of the industry has developed new problems for the grower to solve and new disease and insect enemies that must be controlled.

This bulletin discusses the fundamentals of successful celery production for the market and for the home garden, including the latest and best-known methods of controlling the disease and insect enemies of the crop.

Washington, D. C.

Issued June 1922
Revised April 1936
Slightly revised October 1944

CELERY GROWING

By W. R. BEATTIE, formerly *senior horticulturist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration*

CONTENTS

ORIGIN AND DEVELOPMENT OF THE CELERY INDUSTRY

CELERY GROWING AS AN INDUSTRY in the United States really dates from about 1880, at which time the White Plume and the Golden Self Blanching varieties were introduced. Prior to that time certain of the older green types were grown in home and market gardens mainly for local consumption. Statistics for 1938 gathered by the Bureau of Agricultural Economics show that 41,550 acres were devoted to the commercial production of celery and that the total production was over 11,868,000 crates, or 21,811 cars. This does not include celery grown in home gardens or the small lots grown and sold locally, nor does it include that part of the commercial crop which was moved to market by means of motor trucks. The car-lot movement of celery in the United States reached its peak in 1930, when 26,627 cars were shipped. This great development has been due largely to the increased popularity of celery as a food, the improvement of varieties, the adoption of better methods of handling, and the extension of the industry to regions where soil and climatic conditions make it possible to maintain a dependable market supply throughout the year. It should be borne in mind that celery is perhaps the most expensive of all the vegetable crops to grow. The investment in special equipment is considerable, and the cost of fertilizers, seed, and labor is exceptionally heavy. However, these expenses are variable, and no definite figures can be safely given.

Celery belongs to the same family of plants as the carrot, parsley, fennel, caraway, and anise. The characteristic flavor and odor of the members of this family are due to the presence of certain volatile oils in the stems and leaves, and especially in the seeds. Celery is a native of marshy places of the region extending from Sweden southward to Algeria, Egypt, Ethiopia, and in Asia even to the Caucasus Mountains. In its wild form it was known as "smallage"; the only references to its early cultivation seem to be in connection with its production for medicinal use. In its wild form, celery, or smallage, is of spreading habit of growth and has a bitter or pungent flavor and odor. There is mention of a cultivated variety of celery in France in 1623, and in England the seed was sold in 1776 for the growing of plants to be used in flavoring soups and stews. Originally the cultivated celery differed very little from the wild form; the early varieties of celery seem to have been more or less hollow stemmed, the solid-stemmed varieties not appearing until later. Even in recent years, since celery became an important vegetable crop, there were still numerous hollow-stemmed plants found among the solid. Careful selection and the breeding of new varieties have largely eliminated this tendency, and plants having hollow stems throughout are now rarely found. Pithiness of the outer stems frequently occurs in practically all of the varieties, especially when the crop is allowed to become overmature before being harvested.

S. L. Emsweller, of the University of California, reported on rather exhaustive experiments conducted during 1930–31 to determine the exact nature of the so-called pithiness in celery. Emsweller distinguished two types of pithiness. In one of these types hollowness is hereditary. All of the stems of the plant are hollow from the beginning. The other type of pithiness is the result of local conditions. In it the outer stems become spongy and pithy. This condition may or may not reach the heart of the plant; therefore a portion of the plant may remain marketable. No part of plants of the first type is marketable. Inasmuch as the true hollow-stemmed condition is hereditary, it is possible to eliminate it from any strain or variety by proper selection of the seed plants and by growing the seed under such conditions that there will be no chance of cross-pollination from naturally pithy or hollow-stemmed plants. The other form of pithiness may result from exposure of the plants to severe cold, lack of moisture during the growing period, or allowing the celery to remain in the field too long and become overmature. Certain varieties, because of their early maturing character, appear to be more susceptible to the second type of pithiness than others.

Originally celery was not blanched or eaten raw but, as already indicated, was used largely in soups and stews. It was first used raw in the blanched form in England and later in the United States. From a plant that was thought by many to have slight medicinal properties, celery has been raised in estimation to one of the most delicate and delightful of our fresh vegetables.

Credit for the early commercial development of the celery industry in this country is largely due to a group of Holland-American gardeners located in the vicinity of Kalamazoo, Mich., who grew celery as early as about 1874 and offered it for sale to passengers on the trains passing through Kalamazoo. Later, the trainboys and the express messengers on the Michigan Central Railroad trains sold the celery

to passengers on the trains and to people along their route, and a demand for the delicately blanched product was rapidly created.

Normally, celery is a biennial, producing its seed the second season, but occasionally on account of abnormal growing conditions the plants will behave as annuals and bolt to seed the first season. This tendency to premature seeding can be controlled by growing the plants at the proper temperature, as explained later in this bulletin.

LOCALITIES ADAPTED TO PRODUCE CELERY COMMERCIALLY

Commercial celery production in the United States is confined mainly to the northeastern or Great Lakes area and certain districts in Florida and California. However, considerable acreages of celery are also grown in New Jersey, Colorado, Utah, Idaho, Oregon, Washington, and other States. The distribution of the celery-growing industry is determined largely by climatic conditions and soil types. In the northeastern area the greater part of the commercial crop is grown on muck lands. In New Jersey and on Long Island, and also in Massachusetts and Connecticut, there is considerable acreage located on the light sandy loam soils. The Florida crop, especially in Seminole County, is produced on what is called Leon fine sand. In California the principal celery-producing districts are in the Sacramento and San Joaquin River delta sections, where the soil is of an alluvial character. Until recently the southern California districts centering in Los Angeles and Orange Counties were the principal producing sections in that State. Commercial celery growing in Utah, Oregon, Washington, and Idaho is a comparatively recent development, but the climatic and soil conditions of certain sections of these States seem to be well adapted to the production of celery.

From a home- and market-garden standpoint celery may be grown on practically any type of soil except the heavier clays, and even a moderately heavy clay loam can be made to produce good crops of celery for home use by the addition of organic matter and fertilizers.

The ideal conditions for celery production are an abundance of moisture in well-drained soil and a relatively cool growing season—especially cool nights and days of bright sunshine. In the northeastern area, natural rainfall is mainly relied upon to furnish the necessary soil moisture, although the greater part of the muck lands devoted to celery culture are provided with ditches in which the water may be raised to bring the moisture close to the surface. On sandy loam soils any moisture deficiency is usually overcome by the use of overhead or sprinkler irrigation. In Florida subirrigation is practiced for the most part, although open ditches are used in the Sarasota district. In the western districts, especially in California, Colorado, Utah, and Idaho, surface or furrow irrigation of one form or another is employed. Celery requires an abundance of moisture, and therefore its commercial production is limited largely to regions where rainfall is abundant or where provision may be made for irrigation.

INFLUENCE OF CLIMATE ON CELERY PRODUCTION

Climatic conditions and their relation to the production of celery at periods of the year when it finds a ready market have been an important factor in the distribution of the celery industry. During

the early days of celery growing in this country its use was largely confined to the fall and early winter. Later California and Florida came into the field of production on a large scale, and the marketing period was extended to include practically every month in the year. At present Michigan and New York begin shipping celery the latter part of June and complete their shipments by January. California celery is on the market practically every month in the year, with the peak of its shipments from November to March. Florida ships a few cars in December, but the heavy movement from that State occurs from January 1 to June 1, and a few cars are shipped in June. As a rule enough celery is held over in cold storage to supply the market during June and July. However, the demand is at its lowest point during this period.

FERTILIZERS

Formerly stable manure was used extensively as a source of plant food and organic matter for soils in which celery was grown. In a few localities this is still the case, but with the increasing difficulty in securing manure, growers have been compelled to turn largely to soil-improving crops and commercial fertilizers as sources of humus and plant nutrients. Where manure is still used it is applied at the rate of 20 to 30 tons to the acre, being either put on in the fall and plowed under and replowed in the spring, or composted in piles and spread on the land in advance of spring plowing. The quantity and composition of commercial fertilizers used by celery growers varies considerably in the different localities. In the northeastern area an application of 1,000 to 1,500 pounds of a 2–8–16 fertilizer supplemented by 2 to 3 side dressings of nitrate of soda or sulphate of ammonia has been found to give good results on the muck soils. Much depends, however, upon the character of the soil, the number of years that it has been under cultivation, and other factors. Some of these soils require very little nitrogen but considerable potash; others require a more nearly balanced fertilizer with a nitrogen content sometimes as high as 8 percent. In the California districts commercial fertilizers are being used in varying amounts, depending on the plant food requirements of the particular piece of land being planted.

Florida celery growers use large quantities of fertilizers, as much as 8,000 pounds per acre being applied during the crop-growing season. Experiments conducted jointly by the United States Department of Agriculture and the Florida Agricultural Experiment Station have demonstrated that the highest yields were obtained from mixtures relatively high in nitrogen and potash and low in phosphoric acid. In one set of tests the highest yield, 1,025 crates from an acre, was secured from the application of 8,000 pounds of a 4–2–10 fertilizer. The highest average, however, was 806 crates from a 6–2–8 fertilizer. These tests show that for the soils of Seminole County, Fla., where the tests were conducted, the yields were increased by the additional use of nitrogen and potash and decreased by the addition of more than 2 to 4 percent of phosphoric acid when this increase was made at the sacrifice of the nitrogen and potash. From the data obtained in these experiments it would seem that a mixture containing approximately 6 percent nitrogen, 2 to 4 percent phosphoric acid, and 8

percent potash, used at the rate of 8,000 pounds to the acre, gave best results on those lands. One significant point about the Florida experiments was that on the land where no fertilizer was applied no marketable celery was produced.

The source of nitrogen in fertilizers for these soils is important. Organic materials or a mixture of organic materials with mineral nitrogen have given best results. Fertilizers containing nitrogen, one-fourth each from sodium nitrate and ammonium sulphate, and one-half from organic materials from slaughterhouse waste or vegetable byproducts are suitable and furnish a constant supply of available nitrogen to the crop. Such a mixture will not produce unfavorable acidity in the soil, as is the case when most of the nitrogen in the fertilizers is derived from acid-forming salts, such as ammonium sulphate and ammoniated phosphate.

Sulphate of potash, muriate of potash, or potassium magnesium sulphate is suitable for celery. A mixture of these sources of potash for use in celery fertilizers is considered desirable.

Some of the best growers of the Williamson, N. Y., district are using moderate amounts of manure, and in addition about 1,800 pounds to the acre of a fertilizer which is rather high in potash. About 1,000 pounds of this fertilizer is usually distributed and mixed with the soil in advance of planting, and the remainder is used as side dressings during the growing period. In other cases the entire amount of fertilizer is applied in advance of planting. Celery is a rank feeder, and it may be safely assumed by the celery grower or by anyone contemplating planting celery that it will not pay to attempt to grow the crop without the use of considerable quantities of manure or commercial fertilizers, or both. In the home garden a combination of stable manure and fertilizers will give good results. Poultry, sheep, and other special manures may be used advantageously in moderate quantities.

LIME AND MARL

Either lime or marl may be required for the correction of acid conditions in recently reclaimed muck and swamp soils, and on sandy soils in Florida when fertilizers containing ammonium sulphate or other acid-forming salts are used. The amount to apply, however, should be determined by an acidity test in each case. As a rule, these swamplands lose their acidity rapidly once they are cleared and brought under cultivation. In some cases northeastern growers apply 1 ton of hydrated lime per acre to newly reclaimed muck soils to overcome the excessive acidity. It should be borne in mind that muck soils are of two types, one having a calcareous or marl subsoil which causes the muck to be practically neutral, and in some cases slightly alkaline; the other type usually is underlain by sand or a clay that contains no marl or other calcareous material. These soils are frequently extremely acid when they are first reclaimed.

In California it has been found that celery will tolerate a reasonable amount of white alkali, at least after it has made a fair growth. Experiments conducted in 1908–10 on the ricelands of South Carolina showed that celery will tolerate considerable salt; so much, in fact, that an appreciable amount of the salt is absorbed by the plants, giving them a distinctly salty flavor.

WOOD ASHES

Wood ashes, when obtainable, may be used to supply a portion of the potash required in the celery fertilizer. The value of wood ashes depends (1) upon the kind of wood from which they are made, and (2) upon the way they are cared for and protected from the weather. Hardwoods produce the best grade of wood ashes and may contain as much as 5 or 6 percent of potash, but 3 to 4 percent is the usual amount. The potash content of ashes made from softwoods is comparatively low. The value of wood ashes depends very largely upon their being stored where the potash will not be leached out of them by rains or contact with the ground. As much as 1,000 pounds of high-grade hardwood ashes may be applied to the acre while the land is being plowed and fitted for planting to celery. This will be the equivalent of the potash in 1,000 pounds of average fertilizer. Wood ashes also contain 25 to 30 percent of lime, which tends to overcome any acid condition that may exist in the soil. Wood ashes that have been exposed to the weather and badly leached by the rain have very little fertilizer value.

PREPARATION OF THE SOIL

Before planting celery it is necessary to clear away all growth and remove all stumps and roots that would interfere with cultivation. On the muck lands of the northeastern area the natural growth generally consists of bushes and small timber with a great mass of shallow roots, all of which must be removed before the soil can be plowed. In some cases these muck lands are cleared in the fall and early winter and then planted to celery the following spring. In other cases a year is allowed to elapse and some clean-up crop such as soybeans or corn is grown on the land the first season after it is cleared. These soils contain large quantities of raw organic matter, which frequently requires one season to decompose before the soil is in proper condition for growing celery. In all cases the land must be carefully leveled and, where it is divided into beds with intervening drainage and irrigation ditches, the soil taken from the ditches must be spread and leveled so that every part of the land will be uniformly moistened during irrigation. This work is usually performed by means of tractor-drawn graders and floats, and when it is completed the soil surface will be as smooth and uniform as a floor.

In Florida, especially in Seminole County in the vicinity of Sanford, a soil known as Leon fine sand is very largely used for the growing of celery. This is a fine, loamy white sand underlain at a depth of 16 to 20 inches by a compact subsoil which is not easily penetrated. In its natural state this land is largely covered by timber, so that the clearing and stump removal is a difficult and rather expensive operation. Even after the land is cleared it must be worked over a number of times in order to get out all of the roots that would interfere with the growing of celery. Following the clearing and complete cleaning, the land is very carefully leveled, and all depressions are filled; then the ditches are opened, and the subirrigation tiles are installed, the ditches refilled, and the surface again brought to a perfect level or definite grade. In some cases cabbage, peppers, beans, tomatoes, or some other truck crop is planted on the land for 2 or 3 years in order

to get it in the proper condition for growing celery. The uniformity of the irrigation is dependent upon having the surface perfectly graded and leveled.

The final plowing of new land and the regular seasonal plowing of old land generally takes place 4 to 6 weeks in advance of planting the celery. In the northeastern area the plowing of the old land may not be done until about 2 weeks before planting or merely in time to make the basic application of fertilizers. In Florida land to be planted in celery is, as a rule, planted in velvetbeans or cowpeas or is allowed to grow a crop of grass during the summer months, and in some cases a crop of hay is removed. Then the land is given a thorough plowing with a tractor, following which it is disked anywhere from 8 to 12 times to get it in proper condition. The basic application of 1,000 to 2,000 pounds of fertilizer is made during this period of disking in order that the fertilizer may be thoroughly worked into the soil. A crop of corn grown on the Florida lands during the summer leaves the soil in the best condition for growing celery.

In the California celery-growing districts the land is given a thorough preparation at the time of planting and brought into a fine condition of tilth with the soil moistened to within 1 inch of the surface. Where the land is more or less irregular and surface irrigation is practiced, it is flooded and leveled before planting in order to avoid any low spots in which the water might stand after the plants are set. Immediately before planting the field is marked off with what is called a three-board float consisting of three planks, on the bottom of which are spiked three runners which make smooth even furrows about 4 inches deep and 6 inches wide. The celery plants are then set in the bottoms of these furrows; and it is customary, especially during hot weather, to run small streams of water slowly down the furrows as soon as the plants have been set.

The time and methods of applying fertilizers also vary in the different localities, but as a general rule the initial or basic application should be made a week or 10 days before the celery plants are set. It should be borne in mind that muck and other loose soils will require thorough dragging or rolling to make them sufficiently firm before attempting to set the plants. Soils that are too loose at planting time dry out rapidly, and in addition it is difficult to set the plants firmly in a loose soil. Celery growers in the various sections have improvised a great many types of soil levelers and packers that are suited for fitting the particular type of soil on which they are working. Where celery is being grown on a large scale on the peat or muck lands the work of plowing and fitting is done largely by means of caterpillar tractors, as these soils are so soft that horses must be equipped with large boots or bog shoes to prevent their sinking into the soil.

The preparation and fertilizing of soil in the home garden for the growing of celery for home use is a simple matter as compared with the preparation of land for the commercial crop. Very frequently the late or main crop of celery in the home garden will follow some early crop such as peas or early potatoes, and about the only preparation of the soil that is necessary will be to clean off the early crop and either spade or plow and harrow the soil until it is well pulverized. As a rule fertilizers and manure have been used on the early crop, but it is advisable to further supplement this with a reasonably heavy

608729°—44——2

application of well-rotted manure whenever this is available. About 5 pounds of commercial fertilizer can also be worked into the soil for each 100 feet of row to be planted.

Many home gardeners make the mistake of not preparing their celery ground deeply enough. It is important to have the soil thoroughly pulverized to a depth of 10 or 12 inches, and the manure and fertilizer should be worked in to the full depth that the soil is pulverized. The soil should be prepared at least a week before time for setting the celery plants, in order that it may become settled; and if the weather is dry the land should be given a moderate irrigation to increase the soil-moisture content in advance of setting the celery. The irrigating should be done at least 2 or 3 days before the celery is set; then another watering should be given immediately following the setting of the plants.

SEED SUPPLY

As one leading New York celery grower has so aptly stated, "The first essential to growing a good crop of celery is to secure good seed of a desirable strain." This grower follows the practice of purchasing his seed a year in advance and planting a small quantity to determine its purity and trueness to strain and type. In view of the fact that celery seed will retain its viability for 3 or 4 years, this practice of always having a year's supply on hand and testing it may prove a splendid safeguard in more ways than one.

Formerly, practically all of the seed from which the commercial crop of celery was grown came from abroad, and there was little chance to secure seed of known performance or to test it out in advance. At present the greater part of the celery seed used in this country is produced by American growers; it is not only possible to get high-grade seed, but many of the growers of large acreages of celery have their seed specially grown from mother plants that are selected for certain definite characteristics such as compact form and long heart growth. This has given rise to the development of a large number of strains of the leading varieties. In view of the amount of money involved in the production of an acre of celery it is extremely important that only the best seed be planted; furthermore, the quantity of seed required to produce enough plants with which to plant an acre is only 6 to 8 ounces, which is so small that the grower can well afford to pay any reasonable price for superior seed.

VARIETIES OF CELERY

The commercial celery industry of the United States has been based largely on the Golden Self Blanching variety of unknown origin, but which has long been a standard variety in France. It was introduced into this country about 1884. There are two distinct types of celery, (1) the yellow, of which the Golden Self Blanching is typical, and (2) the green or winter celery, of which the old variety known as Giant Pascal is typical. Most of the old standard celery varieties, such as Golden Self Blanching, White Plume, Winter Queen, and Giant Pascal, are of unknown parentage and origin.

Celery varieties have undergone considerable change during recent years, and commercial growers have come to recognize that there is a great difference between stocks and strains within each variety. During the early period of celery growing in this country, growers depended on European-grown seed, but superior strains of American-

grown seed are now available. Celery growers now look to the plant breeder for the solution of some of their most serious problems. Among these are the celery yellows disease, premature seedstalk development, pithiness, and early maturity. These problems have already been attacked by the plant breeder, and marked progress has been made in reducing losses. Celery growers have largely determined the variety and strain that meet their requirement and are planting this strain year after year. In some cases entire producing sections are planting the same strain in order to standardize their product in accordance with the market requirements.

Easy Blanching is a tall celery of the yellow type resembling Golden Self Blanching, but a little later in maturing. It has bright rich green foliage. It is claimed that Easy Blanching is hardier and more resistant to blight than Golden Self Blanching.

White Plume is the earliest and most easily blanched of all celery varieties, but it is only medium in flavor and does not keep well.

Golden Plume is one of the best of the early varieties. It is somewhat resistant to blight and keeps well in storage. The plants are medium in size, compact, and stocky. Golden Plume is earlier and more vigorous than Golden Self Blanching.

Michigan Golden, developed by the Michigan Agricultural Experiment Station, is a desirable commercial type of celery that is resistant to the fusarium yellows disease.

Non-Bolting Golden Plume, Golden Pascal, Crispheart, and Golden Supreme are among the newer varieties developed and introduced by the Ferry-Morse Seed Co.

Giant Pascal, the oldest of the green varieties, is still the standard for quality but is extremely difficult to blanch. It grows to large size, is late in maturing, and is a splendid keeper.

Winter Queen is a dark-green dwarf celery resembling Golden Self Blanching in habit of growth. It matures earlier and is more easily blanched than Giant Pascal.

Fordhook is one of the best of the winter-celery varieties, having excellent keeping qualities. The plants are somewhat dwarf in habit of growth, and the leaf stems are thick and heavy. This variety was introduced by the W. Atlee Burpee Co. in 1915.

Utah, sometimes called Salt Lake, is a strain of green celery of high quality that has been developed in the region of the Great Salt Lake in Utah. It is about 1 week to 10 days later than Giant Pascal, of which it is probably a hybrid or selection.

Golden Pascal is a dark-green selection from Golden Plume, which, it is claimed, combines the higher quality and heavier stalks of the green celery with the early maturity and easy blanching of the yellow type.

GROWING PLANTS FOR COMMERCIAL USE

In the northeastern area it is essential that the early celery plants be started in greenhouses. The second early crop and the late crop, under favorable conditions, may be started in coldframes or in outdoor beds. The date of planting the seed in greenhouses for the early crop varies among growers from January 15 to April 1, but a large part of the crop is started during the first week in March. One of the problems in growing a crop of early celery is to prevent the plants from shooting or bolting to seed.

In Cornell Agricultural Experiment Station Bulletin 480, Premature Seeding of Celery, is reported a series of experiments conducted by H. C. Thompson, of the New York State College of Agriculture. In these experiments it was found that bolting to seed was due primarily to subjecting the plants to low temperatures during the plant-growing period. The seed used in these experiments was planted on December 10, January 10, February 10, February 25, and March 10. The resulting plants were divided into several lots for different treatments. Some of them were kept dry, while the comparison lots were normally watered. Other lots were frozen, and still others were held in coldframes at temperatures below 50° F., but above freezing. In every case where the plants were carried in the coldframes at temperatures below 50° for a period of 2 weeks or more, there was a high percentage of seeders. Plants from the same seedbeds kept in the greenhouse at temperatures above 65° did not produce a single seeder in the field, whereas as many as 95 percent of those kept in the coldframes for 30 days were seeders.

It was also found that subjecting the plants to higher temperatures following their being kept at low temperatures would, as a rule, prevent their bolting to seed, provided the seed shoot had not started before the change to a higher temperature was made. A period of 2 weeks or more of low temperature after the plants were set in the field might also cause bolting to seed, although a corresponding period of high temperatures immediately following might correct this injurious effect of the low-temperature period and prevent bolting. Seedsmen and plant breeders are now endeavoring to produce a strain of celery that will be resistant to unfavorable low temperatures and the tendency to bolt.

The results of these experiments definitely clear up a problem that was a source of annoyance and loss to celery growers for many years and places the control of the difficulty directly in their hands. Celery is a biennial and under normal conditions produces its seedstalks and seed the second season after planting. For this reason it is not advisable to sow seed too early in the fall or winter with the idea of holding the plants over in coldframes or protected beds for early planting. The only safe plan for the northern early-celery grower to follow is to grow the plants in a greenhouse at a temperature of about 70° F. and to so time the sowing of the seed that the plants may be kept growing from the start and be set in the open after danger of a prolonged period of cold or rainy weather is past. Where spring planting is delayed by a period of cold, rainy weather and the plants are getting too large in the greenhouse they may be checked moderately by being watered lightly and held slightly dry. Under no conditions should they be checked by a prolonged period of lowered temperature as this will result in the formation of seeders after the plants are set in the field or garden.

Celery plants grown in open beds for the main or late northern crop may produce a large percentage of seeders if the plants are subjected to a prolonged period of cold weather during the time that they are in the plant beds. For this reason many northern celery growers start the plants for their late or main crop in coldframes, where a temperature of about 70° F. may be maintained by means of sash or cloth covering on the beds. Plants for the early crop in Florida are grown during the late summer when the temperature is

usually about 70° F., but the seed for the main or winter crop is frequently sown in November, and a high percentage of seeders frequently results from low temperatures in January and February. Growing plants in protected beds where the temperature may be held above the danger mark will safeguard against loss from seeders. The Golden Plume type appears to be less susceptible to premature seeding than the older Paris Golden or Golden Self Blanching.

One of the best methods employed by northern growers for starting celery plants for the late or main crop is to sow the seed on 6-foot beds that are slightly raised above the general level of the soil, with paths about a foot in width between the beds. After the beds are leveled the surface is gone over with steel rakes following which the seed is scattered broadcast. In case the beds are sprinkled or there is a shower following the sowing of the seed this will provide sufficient

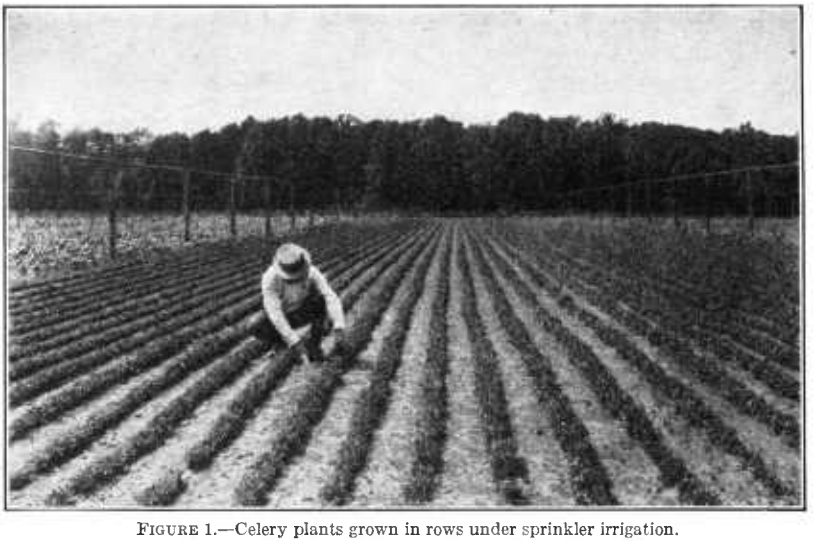


FIGURE 1.—Celery plants grown in rows under sprinkler irrigation.

covering and no additional raking will be necessary. In Florida the seedbeds are frequently covered with pieces of burlap made by ripping the seams of fertilizer sacks. The burlap is laid directly on the surface and is removed after the seeds begin to sprout. Besides being covered with burlap, the plant beds are frequently shaded with sheets of muslin stretched on wires, or a framework of laths is constructed above the beds.

Certain celery growers of the northeastern area prefer sowing the seed in rows or drills, as shown in figure 1, rather than broadcasting it in beds, especially for growing the late-crop plants. When this plan is followed the land is well fitted and the soil made very fine, being dragged to a smooth surface, then the celery seed is sown in rows about 10 or 12 inches apart by means of a seed drill. Where celery plants are grown on a very large scale the land is plowed, harrowed, and dragged to a smooth surface, after which the seed is sown with a grass seeder and the surface of the soil raked over very lightly or watered to cover the seed. In this case no walks or raised beds are provided, the seed being sown broadcast. One objection

to this method is that it is difficult to keep the plants free from weeds. When the seed is drilled in rows, light cultivation with wheel hoes makes it possible to keep the plants free from weeds and growing rapidly. On the whole, a better grade of plants can be produced when the seed is planted in rows because of the wider spacing and the chance to hand weed and cultivate.

Thin seeding will aid in the production of stocky plants. If the plants are grown on greenhouse benches or in sash-covered beds not more than one-half ounce of seed should be sown on each 100 square feet of bed surface. This should produce approximately 6,000 to 7,000 plants. For growing the plants necessary to set an acre of celery 800 to 1,000 square feet of bed surface will be required, varying with the locality and the spacing of the rows in the field. Where wide spacing is practiced and not more than 28,000 plants are set on an acre, 500 square feet of bed surface will produce the necessary plants. Where closer spacing is followed and from 50,000 to 60,000

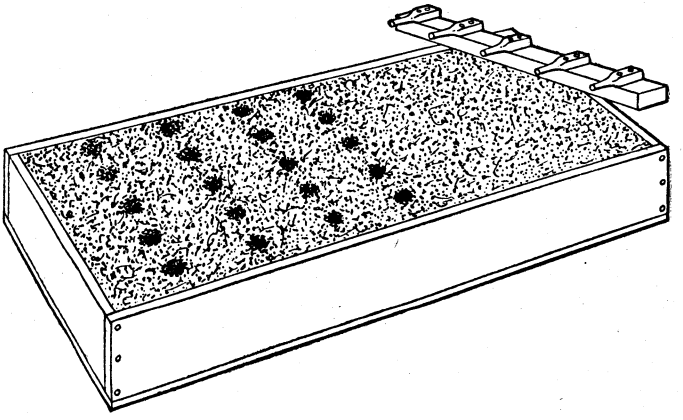


FIGURE 2.—A tray, or flat, used for transplanting celery, with a marker for making holes in the soil, into which the seedlings are set.

plants are required for an acre, at least 800 square feet of plant bed should be provided, and 1,000 square feet is even better. Celery growers who plant 50,000 to 60,000 celery plants on an acre usually sow 8 ounces of seed for each acre to be set. Those planting a smaller number of plants to the acre figure on 4 to 6 ounces of seed for each acre.

It requires from 5 days to 2 weeks for celery seed to germinate and for the seedlings to appear above ground. During this period the beds must be very carefully watered, and the surface must never be allowed to dry out. If celery is grown on a large scale, overhead or sprinkler irrigation is usually employed as a means of watering, but if on a smaller scale, sprinkling cans are used. On some of the muck soils of the northeastern area the water level in the soil is raised so as to keep the seedbeds moist. In California the beds are kept at the proper degree of moisture by running streams of water in the furrows between the plant beds. In Florida the plant beds are kept moist by subirrigation from tiles or open ditches, or by allowing small streams of water to flow around the beds.

Extreme care must be taken in watering celery plants grown in greenhouses and hotbeds to prevent the development of the disease known as "damping-off." This disease is also especially troublesome in the southern sections, where the seed is sown late in the summer, while the weather is still extremely hot. Moderate watering will largely prevent the development of this disease. In case the disease does start, the plant beds should be allowed to become just as dry as possible without serious wilting of the plants.

Celery plants should be given at least one good spraying with bordeaux mixture before being moved from the plant beds. The plants should also be given a moderate to heavy watering before being moved. A certain amount of hand weeding will usually be necessary to keep the plant beds clean, but where the seeds are sown with a drill the rows may be cultivated with a wheel hoe, thus greatly reducing the hand weeding. Some growers follow the practice of mulching between the rows of seedlings to keep down weeds and to conserve moisture. Good plants are essential to the production of a profitable crop of celery, and constant attention is required in order to produce good plants.

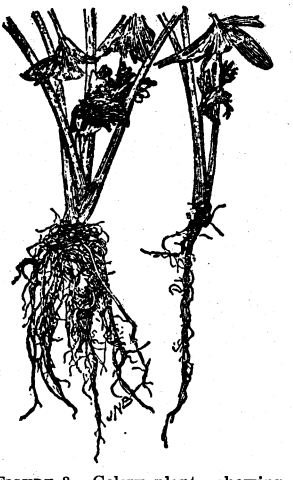


FIGURE 3.—Celery plants, showing the effect of transplanting on the root system due partially to the fact that each transplanted seedling is given sufficient space for its proper development.

For the home garden 200 or 300 celery plants may be started by sowing the seed in a small wooden tray in the house. When the plants are of sufficient size they may be transplanted into larger trays and spaced about 2 inches apart in each direction. Occasionally plants for setting in the home garden may be purchased from some plant grower, but usually a better grade of plants may be secured by growing them at home and transplanting them. Special care is required during the first 2 or 3 weeks after the seed is sown to see that the soil does not dry out. After the plants come up they should be given plenty of sunlight, and care should be taken that they are not overwatered The plants will usually be large enough to transplant in about 3, or at most 5, weeks after the seed is sown.

TRANSPLANTING

Plants for the early commercial celery crop grown in hotbeds and greenhouses are sometimes transplanted from the seedbed to trays (fig. 2), to greenhouse benches, or to heated frames.

The transplanting usually takes place about 4 to 5 weeks after the seeds are sown, or as soon as the plants are large enough to handle. In transplanting, the seedlings are spaced uniformly about 2 inches apart in each direction, and as a result they form large masses of fibrous roots, as shown in figure 3. In transferring these plants from the trays or beds to the field or garden it is the practice to run a knife or trowel in each direction between the plants, cutting the soil surrounding their roots into blocks (fig. 4) which are easily handled so that their growth is checked very little when they are moved. The

greater part of the early crop and practically all of the late crop, however, is handled direct from the seedbeds to the field or garden without intermediate transplanting. Tests have shown that fully as uniform a stand and crop can be secured when the plants are lifted from the seedbed and transferred directly to the field as by intermediate transplanting and with less cost and labor, the only difference being a few days in earliness in favor of the transplanted plants. If, however, it is desirable to transplant into trays, the work can be greatly facilitated by the use of special markers for making holes in which to set the plants.

The wooden trays used for transplanting are about 12 inches wide, 22 inches long, and 3 inches deep, and each holds about 50 plants. The soil in the trays should consist of 2 parts good garden loam, 1 part old rotted manure, and 1 part sand or peat, mixed together and

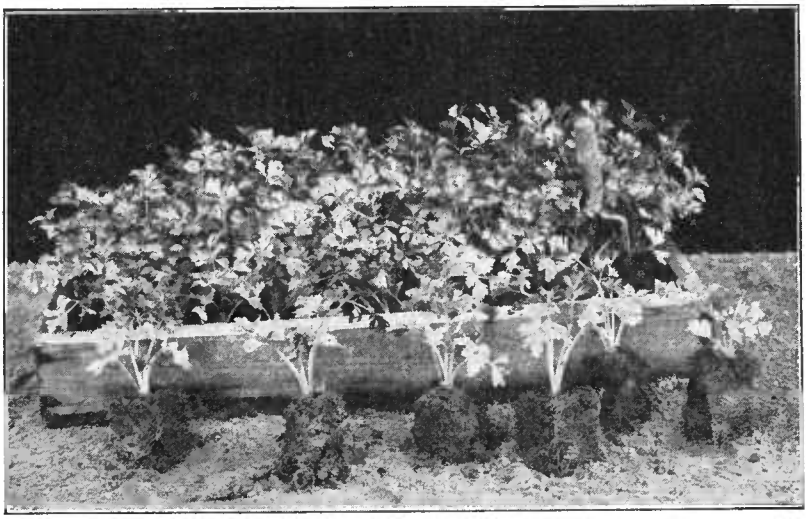


FIGURE 4.—Transplanted celery plants blocked out by cutting between them with a knife or trowel.

run through a fine screen to take out any lumps. The trays are filled heaping full of the soil, then stroked off even with the top by means of a straight piece of board. Before the plants are set, a block of wood or small board is used to firm the soil slightly so that it will be about half an inch below the top of the tray. The plants must be watered immediately after they are transplanted, and the trays kept in a shaded or partially shaded place for a day or two after transplanting, in order to give the plants a chance to recover. Following this they are kept in full sunlight and at a temperature of between 65° and 70° F.

PLANTING CELERY IN THE FIELD OR GARDEN

Celery growers in the different sections have worked out schedules of dates for sowing the seed and transplanting the plants to the field, in relation to weather conditions at planting time and the time that the crop should go on the market. In the case of the northern early crop the different operations are timed so that the plants will go into

the field after late spring frosts are past and there is little danger of a prolonged period of cold, rainy weather. The planting dates for the late or main crop in the northern sections vary from June 10 to about July 20, with the main planting season during the last 2 weeks of June and the first week in July. In Florida and California the planting season extends over a long period, as it is desirable to have a continuous supply of celery for the market from January until June. The plants should remain about 2 months in the seed and plant beds and require 4 months, or about 120 days, for growth in the field. With these points in mind, the grower can so time the different operations that his crop is ready for the market when the demand is greatest.

PLANTING DISTANCES

Planting distances vary with locality and with the method of cultivation. The early celery crop of the northeastern area is frequently grown in rows as close as 24 inches with the plants 6 inches apart in the rows. This spacing will require approximately 44,000 plants to the acre. The plants are sometimes set in 6-foot beds with six rows to the bed and the plants 6 inches apart in the rows. Spaces approximately 2 feet in width are left between the beds. For this method of planting approximately 60,000 plants are required per acre. A portion of the northeastern late crop is grown in rows 38 to 42 inches apart in order that the celery may be banked with soil for blanching. Under this system of planting 23,000 to 25,000 plants are required for planting an acre. In Florida the rows of celery are usually spaced 28 to 32 inches apart, the plants being set 4 to 6 inches apart in the rows and from 48,000 to 54,000 plants per acre being required. In California, where the celery is grown by means of furrow irrigation, the rows are spaced from 3 to 4½ feet apart, the usual distance being 3½ feet, with the plants 6 to 8 inches apart in the rows. If these planting distances are adopted, from 18,000 to 25,000 plants will be required to set an acre.

The greater part of the commercial celery crop is grown in single rows, but occasionally growers plant in double rows, the companion rows being approximately 6 inches apart and the plants 6 inches apart in the rows. This practice of planting in double rows is not advisable because it promotes the development of such diseases as pink rot (p. 24) and blights (p. 20) and it is more difficult to spray effectively than where the plants are set in single rows. The present tendency among growers is to set the plants in single rows but with the rows only 24 to 30 inches apart so that the celery will crowd sufficiently to blanch itself without the use of boards, paper, soil, or other blanching material. Owing to the fact that celery crops must be sprayed to protect them from diseases, proper provision should be made for the passage of spraying equipment through the fields. In many cases it has been found necessary to build special equipment, but whether that is necessary or not, the width of rows should be adapted to the type of spray equipment that is to be used. The largest returns are secured where 50,000 to 60,000 plants are set to an acre. This calls for very intensive cultivation, and the planting distances should be governed by the type of tools that are to be used.

608729°—44——3

PLANTING BY HAND

Formerly celery plants were set entirely by hand with trowels or round-pointed dibbles, the men doing the planting usually working astride the rows and on their knees, as shown in figure 5. Before the seedlings are lifted the plant bed is given a thorough watering, and as the plants are lifted they are placed in trays, baskets, or metal pans, from which they are dropped ahead of the planters by boys and girls. In other cases they are taken direct from the pans or trays by the planters. The latter method has the advantage that the plants do not dry out, but the planters cannot make as good headway as when the plants are dropped for them. Plants that are 2 to 3 inches in height in the plant bed are considered most desirable for hand-set-

FIGURE 5.—Setting celery plants by hand.

ting. In cases where the plants become slightly overgrown and more than 4 inches in height before being set, it is possible to trim off a portion of the tops without greatly interfering with the growth of the plants.

Where celery plants are set by hand the rows are marked with a marker similar to that used for other transplanted crops. In some cases lines of small rope are used and after they are tightened a hand roller is run over them, pressing them into the soft earth, making a mark that can be followed by the planters. Rollers with spotting marks or pegs on their surface to indicate the correct planting distances in the row are frequently used. A roller of this type compresses the soil and makes the planting marks at one operation. As a general rule, however, the distance between the plants in the rows is determined by the planters without the aid of any special marking device.

For the most economical and effective setting of celery the work should be well organized. The men who do the actual planting occupy

the key position, and the remainder of the gang should be so assigned as to keep the setters well supplied with plants and to keep the plants watered behind the setters. With a crew of five or six persons, two would be required to get up the plants, one to transport the plants and help with the marking, two to set the plants, and one to water. In Florida it is customary to organize a gang of about 12 or 13 men, boys, and women, with 4 women to pull and sort the plants, 4 boys to drop the plants ahead of the setters, 2 men to set, 2 men to water, and 1 extra or utility man to keep the work going.

PLANTING WITH MACHINES

Recently a number of rather satisfactory motor-driven machines have been developed for setting the commercial celery crop. The plants are fed into a device which automatically opens a furrow, places the plants, and closes the soil around them. Certain of these machines are fitted with a watering device which injects a small quantity of water around the roots of each plant. Where these plant-setting machines are employed, two or three persons are required at the seedbeds, one boy to transport the plants to the field, one man and two boys to operate the setting machine, and one man to keep the machine supplied with water, making a crew of seven or eight persons. Celery plants that are 3 to 4 inches in length and rather slender are best adapted for machine setting.

In the northeastern celery-growing districts, plants that are set by hand are watered directly behind the planters, usually by means of sprinkling cans. In case an overhead or sprinkler irrigation system is provided, the water is turned on as soon as the plant setters have completed setting the rows that are in range of the sprinkler.

In Florida, where subirrigation of the celery fields is practiced, the water level in the soil is raised during the planting period so as to bring plenty of moisture near the surface, but the plants are also watered by hand following the transplanting. In California the plants are set in a furrow and a small stream of water is allowed to flow through it directly behind the planters. The main points in setting celery are to set the plants at approximately the same depth that they grew in the plant bed but in no case so deeply that soil will be washed into their hearts, and to firm the soil thoroughly around the roots of each plant.

CULTIVATION

While the greater part of the work of cultivating the celery crop is performed by means of horse-drawn or motor-driven tools, some hand weeding and hand hoeing are necessary. The amount of hand work required, however, will depend largely on the method of planting. There will be a minimum of hand work where the plants are set in single rows with the rows far enough apart to permit horse or motor cultivation. Where the celery is closely planted in beds a large part of the work of cultivating will unavoidably be done by hand. Shallow cultivation should be practiced and the soil kept loose to a depth of about 2 or 3 inches. The soil should be stirred as soon after a rain or irrigation as it becomes dry enough to work. In case of dry weather and where irrigating facilities are inadequate, the surface should be stirred very lightly about once a week in order to maintain a dust mulch.

Ordinary garden cultivators of the one- and two-horse types are used very largely for working the celery crop and riding cultivators with special attachments are sometimes used. The main objective, however, is to stir the soil shallow and do the work at the least possible cost.

In Florida, where heavy side dressings of fertilizers are used during the growing period, the applications largely take the place of cultivation. Combination cultivators and fertilizer distributors that open a furrow and mix the fertilizer with the soil are used, and these tools have largely supplanted other types of cultivators. In California a number of special tools, including splitters, crowders, bankers, and cultivators equipped with guards, have been devised and adapted to the cultural requirements of the various regions. Celery should not be cultivated when the foliage is wet from rain, dew, or watering. Toward the end of the growing period and after the celery has begun to occupy the space between the rows and shade the ground, no further cultivation will be necessary. A certain amount of weeding and hoeing is always necessary and constitutes one of the chief items of expense in the growing of the crops.

IRRIGATION

Under most conditions definite provision should be made to water celery, especially during periods of scant rainfall. Three systems of irrigating celery are employed by commercial celery growers: The overhead or sprinkler system, the underground or subirrigation system, and surface irrigation. There are two or three types of overhead-sprinkler systems on the market. The one in most common use consists of a pumping plant located on a stream or pond, pipe lines to conduct the water from the pump to the celery fields, and lateral lines of overhead pipe at intervals of 50 or 60 feet (fig. 1), supported on posts and fitted with small nozzles every 3 feet. The lateral or distribution pipes are provided with a valve and a swivel joint where they connect with the main feed pipes. Water is forced through the pipes at a pressure of 35 to 50 pounds per square inch, and the direction of the streams from the nozzles is changed from time to time, so that all parts of the field may be evenly watered. This system works best when a light breeze is blowing across the irrigation line, as the wind aids in the distribution of the water.

Other types of sprinklers are designed to be attached to the end of a hose and moved from place to place as desired to secure the proper distribution of the water. The cost of installing a complete overhead system varies from $250 to $500 an acre, depending on the number of acres covered, the distance that the water must be piped from its source to the celery fields, and the cost of the pumping plant and the well or pond from which the water is obtained. The pumps are operated by electricity, gasoline engines, and, in a few instances, by steam. In a few cases water is obtained from city mains or other public water supplies.

Two forms of the subirrigation system of watering celery are in use. The one most commonly employed in the northeastern area, especially on the muck lands, consists of open ditches located every 50 to 70 feet, which serve as drains during periods of excessive rainfall and as irrigation ditches during dry periods. The method employed is to place dams or floodgates at the outlets of these ditches and thereby raise the water level in the ditches to a point where the intervening beds of

soil will be moistened practically to the surface. Inasmuch as these muck areas are generally located on land that must be artificially drained, there is usually an adequate supply of water with which to raise the water level in the ditches. After the celery beds are sufficiently moistened the floodgates are opened and the water allowed to drain off until the soil again becomes dry, when the process is repeated.

The other system of subirrigation consists of laying lines of open-joint drain tiles below the depth of plowing, and feeding the water through these lines of tiles and allowing it to escape into the soil through the open joints. In the Florida celery-growing section, especially around Sanford, the surface soil is underlain at a depth of 16 to 18 inches by a rather impervious subsoil that prevents the downward escape of the water. The lines of irrigation tile are laid almost directly upon this bed of subsoil, and water is supplied from flowing wells, which are usually located at the highest point in the celery field so that the water can be carried to the various parts of the field by gravity. The lines of irrigation tiles are given a very slight fall and connected at the lower end with a main drain or open ditch. Each line of tile is provided with a cut-off which may be opened during wet weather so that the lines may serve as drains. The installation of a tile subirrigation system calls for careful engineering and proper grading of the tiles; otherwise one section of the field may receive more water than another.

In California, Idaho, Colorado, and other of the western sections where irrigation is depended upon primarily for the growing of the celery crop, the surface system is most universally employed. As already noted (p. 17), the plants are set in shallow furrows, and gentle streams of water are allowed to flow through the furrows around the celery plants. As the celery increases its growth the irrigations are repeated, giving the celery plants whatever water may be required, after which the surplus water is drawn off and the celery cultivated.

Extreme care is required in the irrigation of the celery crop. Cases are on record where crops of early celery in the northern sections have been practically ruined by excessive overhead irrigation. Although celery in its natural habitat is a marsh plant, the cultivated varieties of celery will not grow satisfactorily on a wet soil or on a soil where the water table is maintained near the surface; nor will they give good results where excessive amounts of water are applied overhead either in the form of rainfall or artificial sprinkling. Experienced celery growers determine the need for moisture by the growth and actions of the plants. Under no circumstances do they allow the soil to become so dry as to cause any wilting of the foliage; on the other hand they keep the soil slightly on the dry side so that cultivation may continue and weeds be held in check. Where subirrigation is employed the grower must understand his soil and know the amount of water to apply and the length of time to hold the water in the soil. The same is true with furrow or surface irrigation; however, in the western irrigated regions provision is always made for drawing off any surplus water.

Celery grown in the home garden may be irrigated simply by pouring water carefully along the rows of plants. The water may be applied from pails, or from sprinkling cans with the sprinklers removed. On the whole, it is best to apply the water to the soil around the

celery rather than to the celery itself. Late in the season, after the celery has reached mature size, care should be taken to keep water out of the hearts of the plants; otherwise various forms of rots are likely to cause losses.

MULCHING

Mulching the celery plants in the home garden immediately after they are set will aid materially in conserving moisture and in protecting the roots from the heat of the sun. Fine manure containing a quantity of short straw is perhaps the best material to use as a mulch, but well-rotted manure is excellent for the purpose and stimulates the growth of the celery. Manure that has been taken from the pit of a manure-heated hotbed makes excellent mulching material for celery. Mulching may not be practical under most conditions in field culture, but it is useful in the home garden.

CELERY DISEASES [1]

As a result of the intensive and extensive culture of celery in more or less restricted areas in this country where the crop is grown on the same soil year after year, conditions have been created that tend to promote the introduction, growth, and spread of many destructive fungus and bacterial parasites that cause heavy annual losses. To combat these diseases successfully, the grower must realize the necessity of preventing infection as well as controlling its spread. Many of the more common celery diseases can be either prevented or controlled by systematically resorting to seed treatment, seedbed and field sanitation, and the field application of fungicides as dusts or sprays.

LEAF BLIGHTS

There are four distinct forms of celery leaf blight; two late blights (*Septoria apii-graveolentis* Dorogin, and *S. apii* (Br. and Cav.) Chester), early blight (*Cercospora apii* Fresen.), and bacterial leaf spot (*Bacterium apii* I. C. Jagger). These will be described separately, but since all can be controlled by the same treatment, measures for their control will be discussed for the group as a whole.

LATE BLIGHT

The late blights are the most destructive of the leaf blights and have become prevalent and destructive diseases in all sections where celery is grown. The late blights usually appear in the late summer or early fall, and this accounts for the colloquial name "late blight." However, in Florida and California the disease may be found during the fall, winter, or early spring.

The late-blight disease (*Septoria apii-graveolentis*) (fig. 6) attacks all above-ground parts of the celery plant, usually being more conspicuous and more destructive on the older leaves and leaf stems. The disease appears on the leaf first as small yellow areas; these gradually enlarge, become brown, and later almost black. The black appearance is due to the formation of numerous small pycnidia, which are really receptacles for the many tiny spores or seedlike bodies. The disease is spread by the distribution of these spores or seedlike bodies. The other form of late blight (*S. apii*) (fig. 7)

[1] Prepared by A. C. Foster, senior pathologist, and F. L. Wellman, formerly associate pathologist, Division of Fruit and Vegetable Crops and Diseases.

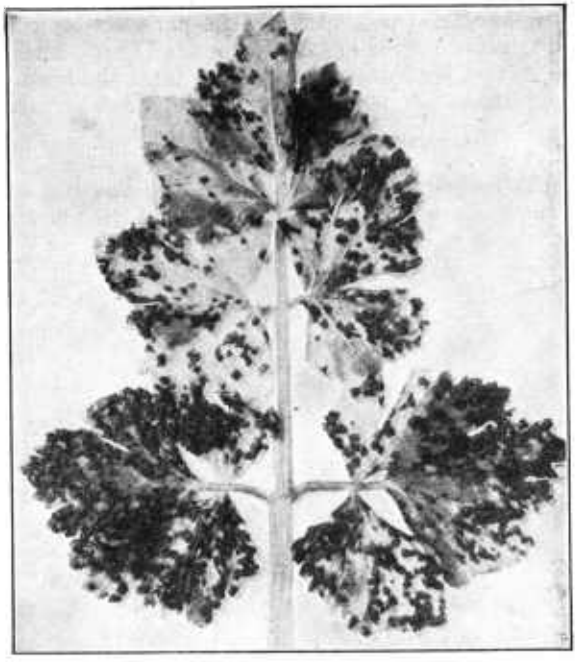


FIGURE 6.—Late blight of celery. (Fla. Agr. Expt. Sta. Bull. 173, 1924.)

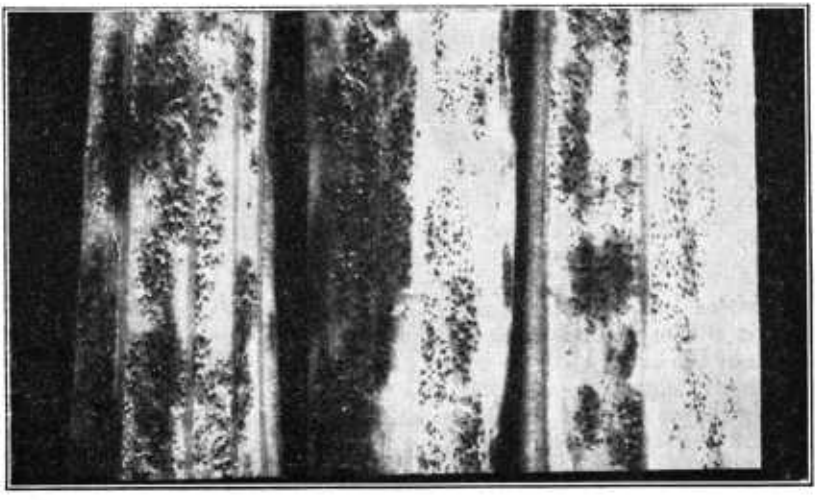


FIGURE 7.—Late blight of celery on stalks. Enlarged to show pycnidia. (Fla. Agr. Expt. Sta. Bull. 173, 1924.)

has larger lesions which are more nearly circular but also bear the characteristic pycnidia. The disease is easily distinguished from early blight or bacterial leaf spot by the presence of these numerous small black pycnidia covering the lesions. The pycnidia are usually found on the leaves, leaf stems, seedstalks, and the seed, and they act as a source of infection to perpetuate the disease year after year.

EARLY BLIGHT

Early blight (fig. 8) is found in all of the leading celery-growing sections. This disease is most prevalent and destructive in Florida

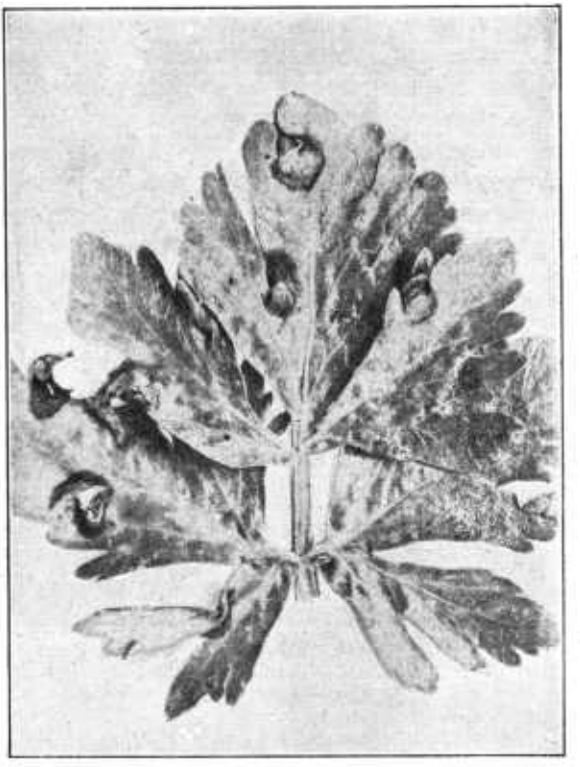


FIGURE 8.—Early blight of celery. (Fla. Agr. Expt. Sta. Bull. 173, 1924.)

but causes considerable annual losses in New Jersey and other Eastern States. The disease may appear at any time during the growth of the crop, but it is usually more prevalent during the warmer months of the growing season.

Early blight attacks the leaves and leafstalks, but it is more prevalent and destructive on the older leaves. It appears first on the leaves as small, circular, yellowish-brown spots. These spots enlarge rapidly, becoming darker in color and eventually appear as ashen-gray spots. The ashen-gray appearance is due to the growth of the fungus, which produces a heavy crop of small, needlelike spores over the surface of the "spot" on the leaf or stem. The disease is spread to other plants by the distribution of these spores by wind and rain.

The celery trimmings left in the field furnish a means for the carrying over of the disease in the soil and are a source of infection of the plants the following year.

BACTERIAL LEAF SPOT

The bacterial leaf-spot disease (fig. 9) is now of considerable economic importance in New York, Michigan, Minnesota, and Indiana. It appears on the leaves as small circular rusty-brown spots that can be easily distinguished from those of either late or early blight by the absence of black pycnidia and the ashen-gray fruiting mold. The disease is confined almost entirely to the leaves.

CONTROL OF LEAF BLIGHTS

It is far more important to prevent the appearance of the three leaf blights than to attempt to check their spread after they have become

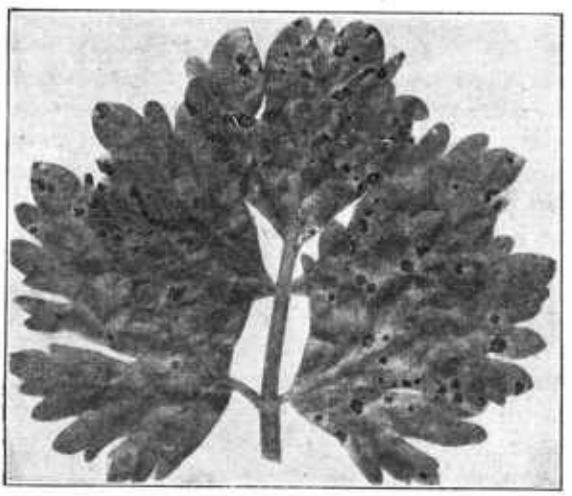


FIGURE 9.—Bacterial leaf spot on celery. (I. C. Jagger, Jour. Agr. Research 21: 185, 1921.)

well established. Seed treatment, field sanitation, and crop rotation should receive as much attention as the application of spray materials.

Late blight is definitely known to be carried on the seed, and there is reason to suspect that both early and bacterial leaf spot are carried in a similar way. A simple method of treating the seeds to prevent this is to place them in a cheesecloth bag, soak in warm water for 30 minutes, drain, and then submerge in a 1 to 1,000 solution of corrosive sublimate for 30 minutes. The seed should then be rinsed thoroughly and dried before being sown. A 1 to 1,000 solution of corrosive sublimate can be made by dissolving one-eighth ounce of mercuric chloride (corrosive sublimate) in 1 gallon of water. **This chemical (and the solution made therefrom) is a deadly poison and should be handled with great care. Any of the solution that is left after the seed treatment should be poured into the ground where there will be no danger of any animal or person drinking it.** Corrosive sublimate solution attacks metals and should be handled in glass, wooden, or glazed-earthenware containers.

The young plants in the seedbeds should be sprayed with a 4–4–50 bordeaux mixture or dusted with 20–80 copper-lime dust every week or 10 days. Spraying the seedbeds is advocated even though the disease is not apparent. If any of the leaf blights appear in the field the application of 4–4–50 bordeaux mixture every week or 10 days should continue until the celery is prepared for blanching. In Florida more frequent application of bordeaux mixture is necessary. During prolonged rainy or cloudy and damp weather three or more applications per week may be required to hold the disease in check.

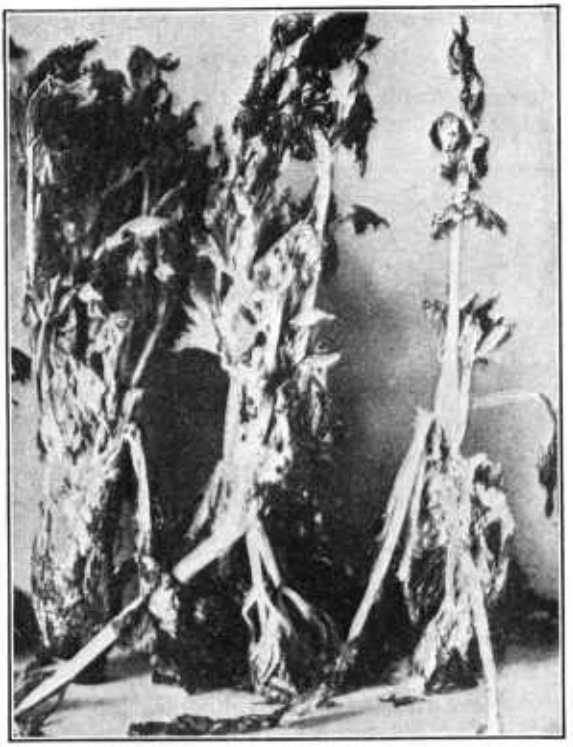


FIGURE 10.—Pink rot, or celery drop.

PINK ROT OF CELERY

Of all celery diseases, pink rot (limb rot, drop, or watery soft rot) (fig. 10) is one of the most destructive and difficult to control. The fungus parasite (*Sclerotinia sclerotiorum* (Lib.) Massee) causing this disease also attacks lettuce, cabbage, and many other crops, and in many instances is responsible for what is commonly called "damping-off" in seedbeds (p. 13). The disease frequently appears in greenhouses and is apparently widely distributed in all vegetable sections. The disease also causes considerable damage and loss by attacking celery in transit and storage.

Pink-rot disease on older celery plants is usually found near the surface of the ground, the fungus probably entering the plant through injuries or growth cracks and gradually growing up the stalk. The disease is first noted as a watery lesion or spot on the stalk; later, the

fungus appears on the surface as a delicate white cottony growth. As the disease develops, a pinkish color appears, and eventually the irregularly shaped black resting bodies or sclerotia are formed. These resting bodies may remain dormant in the soil for several years and constitute a source of infection to succeeding crops. Under favorable conditions the sclerotia in the soil germinate and send up fruiting structures similar to small mushrooms. Many small ascospores or seedlike bodies are ejected from these and distributed by the wind and rain, frequently causing infection on healthy plants.

Once the pink-rot fungus is established in the soil the disease is difficult to control. The removal of infected plants and the use of a definite system of crop rotation is advisable. Thorough spraying of the plants with bordeaux mixture will help materially to check the spread of the disease. Diseased plants have a bitter taste and are not edible. If slightly infected plants are packed in crates with healthy ones the latter usually will become infected, and thus the entire lot may be destroyed. Since the disease appears to thrive and continue to grow at low temperatures (30° to 31° F.) every precaution should be taken to discard infected plants.

BLACKHEART

The blackheart disease (fig. 11) has appeared in all sections where celery is grown as a commercial crop. The disease is especially prevalent and destructive in Florida, and is often serious in California, Utah, Wisconsin, Minnesota, New York, and New Jersey. The disease is nonparasitic in nature, no parasitic fungus or bacterial organism being responsible for its appearance; however, very often secondary organisms enter the tissue affected with blackheart and cause further soft-rot decay.

The disease appears first in the young tender leaves of the heart as brownish discolored areas around the leaf margins and veins. The discolored areas enlarge, become darker, and finally black; hence the name blackheart. The disease is often localized in the leaf margins, and after partial recovery, growth is resumed, a blackened tip remaining on the fully developed leaf. Often the disease develops in successive attacks with the growth of each whorl of leaves from the crown. The entire crown may become affected and, if secondary decay follows, will be destroyed. A partially or completely affected plant is usually discarded as commercially worthless.

Since the appearance of the disease is attributed mainly to unbalanced soil-moisture and nutritional conditions, any suggested control measures must be along the line of better cultural practices. The culture of celery should be limited to regions where the soil is well adapted to the growth of the crop. Facilities should be available for supplying uniform moisture at all times. Extremes of drought and excessive soil moisture must be avoided (fig. 12). The common practice of Florida growers of raising the water table under celery just before harvest is responsible for a large part of the disease in that State. Experimental evidence indicates that with increasing amounts of fertilizer, especially nitrogen, there is a corresponding increase in the amount of blackheart when other conditions, such as drought or excessive water, are favorable for its development.

Attempts to grow celery during months when high summer temperatures prevail will usually lead to disaster. When temperatures

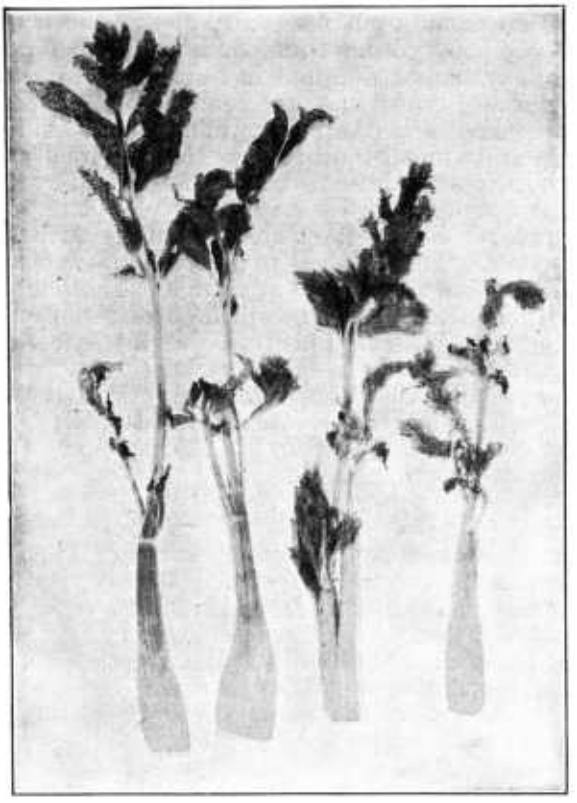


FIGURE 11.—Blackheart of celery.

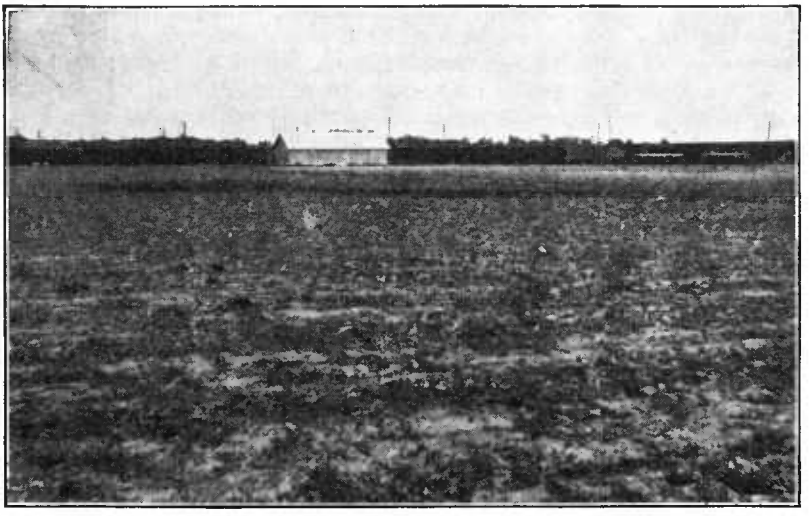


FIGURE 12.—Field of celery destroyed by blackheart as result of excessive water just prior to harvest; plants in foreground cut, those in background still standing. Sanford, Fla.

are high it becomes more difficult to maintain adequate moisture in the soil, because of the excessive amount of water lost by the plants as a result of increased transpiration and because of the unusually high rate of evaporation of water from the soil.

The use of excessive quantities of fertilizer, especially any form of nitrogenous material, should be avoided, because such a practice is especially favorable to the development of blackheart. However, the disease can usually be largely prevented by carefully avoiding the use of excessive quantities of water when irrigating, especially late in the season, and also by preventing excessively long periods of drought as the crop approaches maturity. Adequate irrigation of muck or peat soils during late summer is important, since this type of soil does not liberate its moisture as freely as a sandy loam or loam soil.

ROOT KNOT

Root knot is one of the most serious diseases of celery in Florida. The disease is also present in the Pacific Coast States and is frequently found in other States where seedling plants are grown in the greenhouse. Root knot is caused by minute eelworms commonly called nematodes (*Heterodera marioni* (Cornu) Goodey). These parasites enter the roots and secrete a toxic substance that evidently stimulates the development of the characteristic enlargements of the roots.

Only the roots of the celery plants are directly attacked. The presence of the disease is shown mainly by the peculiar enlargement of the roots and the stunted or retarded growth of the plants. The affected plants also appear to be starved and are usually yellow or chlorotic. In case the plants become affected early in life, growth is usually stopped.

The control or eradication of nematodes is difficult once they are established in the soil. Every effort should be made to grow plants in seedbeds that are free from nematodes. The seedbeds should be sterilized with steam. The Florida Agricultural Experiment Station advocates applying calcium cyanamide to the seedbed and the field some time before planting, to eradicate the nematodes. Directions for the use of calcium cyanamide are supplied by the manufacturing concerns. However, in light dry soils nematode control may be attained most satisfactorily by an application of carbon disulphide, 100 to 300 gallons per acre, or ⅔ to 2 fluid ounces per hole. The holes should be 6 to 9 inches deep and 18 inches apart each way, arranged in staggered rows. The holes should be covered well after being treated, and planting should not be done for at least 2 weeks, till all the soil has been thoroughly aired. Liquid carbon disulphide is explosive and must be handled with care.

In order to reduce the amount of damage from nematodes in the field, it is advisable to rotate crops, including crops resistant to the attack of nematodes, and to practice clean culture.

PHOMA ROOT ROT

Phoma root rot of celery is now found in nearly all of the commercial celery sections. Usually the disease is of minor importance, but when climatic conditions become especially favorable for it, as during long periods of excessive moisture and cold weather, considerable damage may occur.

The disease is caused by a fungus parasite (*Phoma apiicola* Speg.) which inhabits the soil. The disease usually attacks the plant at the base near the soil surface, appearing as a bluish-green lesion, which later turns brown and then black. Leaves on affected plants wilt and drop to the ground, and the plants as a whole become stunted. On rare occasions the disease may attack the leaves and leaf stems.

The disease is difficult to control, but starting the plants in sterilized soil is advisable. The seedbeds can be sterilized by treating them with a dilute solution of formaldehyde.[2] Since the disease is harbored

FIGURE 13.—Cracked stem disease of celery.

and lives in the soil over winter in trimmings from harvested celery, such material should be thoroughly removed from the celery field at harvest time. Crop rotation also is advisable.

CRACKED-STEM DISEASE

Very little is known about the prevalence and distribution of the cracked-stem disease (fig. 13). The disease appeared in Florida as early as 1921 and since then has become more prevalent and destructive and at present often does serious damage in Wisconsin and Michigan. The cracked-stem disease is nonparasitic in nature. Neither fungus nor bacterial parasites are responsible for its appearance. The specific cause of the malady is unknown, but it appears to be associated with an unbalanced nutritional condition of the soil.

[2] Dilute 1 gallon of formaldehyde with 50 gallons of water and apply 1 gallon of this solution to each square foot of seedbed area. Before applying the solution the soil should be spaded. Three or four days to a week should elapse before the seed should be sown.

The disease is characterized by a rather peculiar transverse cracking of the epidermis or "skin" of the ribs of the leafstalks. The broken epidermis often curls back, leaving open lesions which seriously impair the appearance and quality of the celery.

Recent work carried on by the Florida Agricultural Experiment Station[3] indicates that the application of 10 pounds of borax per acre will materially check the development of this disease. The application of more than 10 pounds of borax per acre is distinctly harmful and may result in greater injury to the celery crop than does the cracked stem disease. The treatments reported in Florida have given good results, but the use of borax in other sections should be carried out with caution, under the supervision of experienced experiment station workers.

VIRUS YELLOWS

The disease virus yellows differs from the fusarium yellows in that it is caused by a virus and is not the result of fungus infection. As in the case of mosaic, the virus lives over from year to year in weeds growing in the vicinity of celery fields and also affects other cultivated vegetables and many ornamental plants. Certain leafhoppers feed on these diseased plants and then carry the disease to celery in the field. The disease is most destructive on the Pacific coast and occasionally causes serious losses. Diseased plants become stunted, the leafstalks are twisted and intertwined, and the leaves are generally yellowed and bleached in appearance. No control of the disease has been developed, but since the virus may occur on weed hosts it is advisable to keep down weeds in the vicinity of celery fields.

FUSARIUM YELLOWS

The fusarium yellows disease of celery is caused by a soil fungus that belongs to the fusarium group. The fungus lives in the soil and will persist for some years in the same field even in the absence of a celery crop. It is well distributed in the northern celery-growing States, is found in the Middle West, and as far west as Colorado. Losses frequently are serious. The fungus enters the root system and causes stunting, yellowing, and in some cases the death of the plant. The fusarium yellows of celery may be controlled only by growing resistant varieties. The commercial Golden types of celery are all very susceptible to fusarium yellows, whereas the pure-green varieties are particularly resistant. The Michigan Agricultural Experiment Station, working in cooperation with the Bureau of Plant Industry, United States Department of Agriculture, has developed several strains of celery that are resistant to fusarium yellows. The Michigan Golden is a desirable commercial type.

SOFT ROT

The soft rot of celery is caused by a bacterium (*Bacillus carotovorus* L. R. Jones) that apparently exists wherever vegetables are grown. The parasite may enter the leaves or other plant parts whenever they have been injured and cause a water-soaked, slimy, soft-rot decay. It is likely to be especially severe in celery that has not been promptly placed under proper storage or transit conditions after harvest. Preventive measures consist chiefly in moving the crop in as rapid

[3] Florida Agricultural Experiment Station Bulletin 307, CRACKED STEM OF CELERY, CAUSED BY A BORON DEFICIENCY IN THE SOIL.

and cleanly a manner as possible. In storage houses, when celery is to be kept for a long period, the temperature should be low (31° to 32° F.) and the ventilation sufficient to keep the air free from excess humidity (90 to 95 percent).

CELERY MOSAIC

The mosaic disease of celery (fig. 14) is introduced through slight wounds into healthy plants. The disease causes brilliant-yellow mottling of the leaves, accompanied by severe stunting of the plant,

FIGURE 14.—A Golden Self Blanching celery plant diseased with the southern celery mosaic, showing stunting, mottling and crumpling of leaves and unsightly browning on petioles. Such plants are discarded at harvest.

and produces brownish, sunken streaks on the leafstalks which render them unfit for use. Mosaic occurs particularly in the Southern States, but it is also found in California and in certain northern celery sections. The disease is transmitted to healthy plants by aphids or plant lice which have previously fed on mosaic plants and carry the infectious juices on their mouth parts. In Florida the disease also occurs on various weeds, particularly on a species of wandering-jew that is abundant in sections where celery is grown (fig. 15). The virus lives over in this weed from season to season and is carried to the celery by aphids which have fed on the weed host. Since the first infection comes

from the weeds which harbor the disease, the most effective means of control has been found to consist in the removal of all weeds from the immediate vicinity of fields or seedbeds. Another form of mosaic is occasionally present which causes an abnormally upright growth of the plant and some malformation of the leaflets but does not produce a noticeable mottling of the foliage. This form of mosaic is less common, but as it is also transmitted by aphids and apparently affects wild hosts the methods of control are the same.

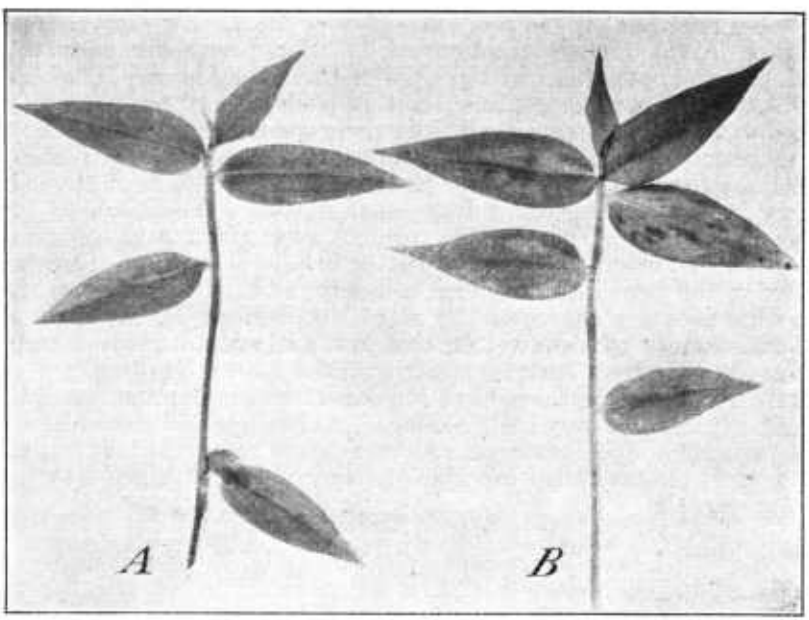


FIGURE 15.—Healthy (*A*) aud diseased (*B*) plants of the wild wandering-jew, the latter acting as the reservoir of the virus that causes the southern celery mosaic. Aphids feed on the diseased weeds and when they crawl over to the celery serve to spread the disease to that crop.

INSECTS AFFECTING CELERY [4]

In the early days of celery growing in the United States, practically no insect troubles were encountered by the growers. However, as the industry became established and developed in various parts of the country, including the southern areas of winter production, insect enemies gradually increased in importance. At the present time the principal insect enemies of celery are the celery leaf tier, the celery looper, cutworms, the red spider, the southern army worm, the tarnished plant bug, and the carrot rust fly.

CELERY LEAF TIER

The celery leaf tier (*Phlyctaenia rubigalis* (Guen.)) is a major pest of celery in Florida producing areas and also becomes troublesome in the North and in California. In the larval stage the leaf tier is about one-half inch long and pale green or whitish. The adult or

[4] Prepared by D. J. Caffrey, senior entomologist, Division of Truck Crop and Garden Insect Investigations, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration.

parent moth is yellowish brown and has a wing spread of about three-fourths of an inch. The larvae of this pest web together the leaves of celery and related plants; they also feed down into the heart of the celery and, by cutting deep grooves in the stalk, render infested plants unfit for consumption. The small white eggs are deposited on the under side of the celery leaves, where they may be seen with the naked eye.

This pest can be controlled by careful treatments with pyrethrum powder mixed with an equal quantity, by volume, of tobacco dust. Tobacco dust has proved more satisfactory than other materials as a diluting agent and is recommended. The treatment consists of making two applications within a period of one-half hour. The object of making the second treatment within such a short period is to kill those worms that have moved from their webs as a result of the first treatment. Approximately 25 pounds of the mixture per acre is necessary for each application. Except under conditions of unusually heavy infestation one treatment—that is, two applications at half-hour intervals—is sufficient to protect any given area of celery. Traction or power dusters give better results than hand dusters in applying the pyrethrum mixture to celery, as it is necessary to force the dust into the center of the plant. **Arsenicals in any form are not satisfactory as a control for this pest and are not recommended, as they may leave a harmful residue on the market product.**

Intensive investigations have indicated that under the conditions existing in Florida very little damage is to be expected from leaf tiers when winter temperatures, on an average, are relatively low, but that when such temperatures are high the use of the pyrethrum-tobacco dust is essential.

CELERY LOOPER

The celery looper (*Autographa falcifera* (Kby.)), or sometimes the closely related cabbage looper (*A. brassicae* (Riley)), is found on celery in all sections but rarely in sufficient numbers to be really injurious. Both have the habit of dropping to the ground when they are disturbed. For this reason, when the celery is handled and packed in crates the loopers will immediately work to the outside and drop off as the crates are being handled. While at times there may appear to be fairly heavy outbreaks of the celery looper, its presence is not considered a serious handicap in the growing of the crop. The pyrethrum-tobacco dust recommended for the control of the celery leaf tier is also effective in controlling the celery looper.

CUTWORMS

Cutworms are injurious to celery in all sections where the crop is produced. The greatest injury from cutworms comes where a heavy crop of grass or weeds has been plowed under in preparing the land for celery. The usual method of controlling cutworms is to use poisoned-bran mash. The standard formula for making the mash is as follows:

Ingredients of mash	In small lots	In large lots
Dry bran	1 peck, or 5 pounds	25 pounds.
White arsenic, paris green, or sodium fluosilicate	¼ pound	1 pound.
Sirup or molasses	1 pint	2 quarts.
Water	3 or 4 quarts	15 to 20 quarts.

In making poisoned-bran mash, add the poison to the dry bran and mix thoroughly with a shovel, or, preferably, with the hands, until every particle of the bran has received a coating of the arsenical. It is a good idea to wear gloves while doing the mixing, as there is danger of poisoning, especially if there should be any cuts or breaks in the skin of the hands; also, one should take care not to inhale the dust from the mixture. The sirup should be added to a small quantity of water, and this sprinkled lightly over the mixed bran and poison while the mixture is being stirred, so as merely to dampen the bran and not wet it. If too much water is added at one time, the arsenical will be washed from the particles of bran. Keep adding the sweetened water and as much plain water as needed with continued stirring until the bran is dampened and forms a crumbly mass that can be easily worked. Some persons add the juice and grated skins of half a dozen oranges to a larger quantity of the mixture to make it more attractive to the cutworms, but this is not essential.

The poisoned-bran mash should be scattered on the surface of the ground late in the evening or about sundown, as the cutworms do most of their work by night. Scattering a little of the mash over the seedbeds before the plants come up will destroy many cutworms. Fields where there are large numbers of cutworms can be largely cleared of them before the celery is planted by scattering bran mash rather uniformly over the entire surface. **Where cutworms appear on celery that is fairly well grown, care must be taken to scatter the mash only on the ground and not in the hearts of the celery plants.**

RED SPIDER

The common red spider (*Tetranychus telarius* (L.)) is sometimes a serious pest on celery during dry seasons, but it seldom gives trouble during seasons of normal rainfall. In the ordinary season the addition of one-half gallon of lime-sulphur solution to each 100 gallons of bordeaux mixture that is being used to spray for disease control will kill the red spider, but in time of drought it is desirable to double the quantity of lime sulphur. The addition of this extra quantity to the bordeaux spray may cause burning of the foliage under a bright sun, but if the application is made late in the day no damage need be anticipated.

Red spiders usually appear in isolated spots and gradually spread to other parts of the field. Their presence can usually be detected by white patches that begin to appear in the fields. When the red spiders become very numerous they climb to the top of the tallest leaves by the thousands and form bright red balls. At this time they spin silken threads which are lifted on the breeze and, if the wind is strong enough, are carried across to other rows of celery, and the red spiders cross over on these slender threads. Heavy dusting of a mixture, by volume, of one part of lime and three parts of dusting sulphur will often check the spread of the red spiders and prevent a general infestation. Should a general infestation develop, thoroughly dusting the entire field with the mixture of lime and dusting sulphur is the usual remedy. The red spider does great damage in reducing tonnage and quality, and more attention should be paid to its control, especially in watching for and dusting the first injured spots that appear.

SOUTHERN ARMY WORM

In the Florida celery fields considerable damage is sometimes done by what is called the semitropical or southern army worm (*Prodenia eridania* (Cram.)). As this insect goes into hibernation during the winter period in Florida, its damage to the celery crop usually occurs in the field on the early planted celery. The larva, or worm, of this insect is hump-shouldered in appearance and ranges in color from black to pale yellow with black spots on the humps. It breeds rapidly and literally devours the celery. Spraying the celery during its early stages of growth with paris green will usually control the southern army worm; then, as the weather becomes colder, the insects go into hibernation, and no further trouble is experienced. The use of poisoned-bran mash, as recommended for cutworms, is effective in controlling the southern army worm. Under no circumstances should arsenicals be applied to celery after it has passed the early stages of growth.

TARNISHED PLANT BUG

In New York State and other parts of the northeastern celery-growing area the tarnished plant bug (*Lygus pratensis* (L.)) has recently appeared as a troublesome celery insect. Its method of attack is to suck the juices of the stalk from a wound made near the upper leaf joint. As a result of this injury the joint blackens, giving rise to the name "black joint." The leaflets above the injured joint turn pale and eventually droop. Various control measures for the tarnished plant bug have been suggested, but according to results obtained in New York,[5] the growers are securing good results by dusting the celery once a week with a mixture consisting of 44 pounds of dusting sulphur, 44 pounds of hydrated lime, and 12 pounds of copper lime dust. On small to half-grown celery 60 pounds to the acre is used at each dusting and up to 120 pounds per acre on large or full-grown celery. Three to five dustings are generally sufficient to give good control.

CARROT RUST FLY

In the Williamson, N. Y., district the carrot rust fly (*Psila rosae* (F.)) has been observed to cause considerable damage to celery. The larvae of the rust fly work at the roots of the celery plants, stunting their growth and in many cases causing their complete loss. This damage occurs especially where celery is planted on land on which carrots have been grown, or immediately adjoining fields of carrots that are seriously affected by the carrot rust fly. The principal injury is done by the second brood of the insect, so where neither celery nor carrots have been planted during the very early part of the season the early brood of the fly fails to find a host plant, and for that reason there is a much smaller second brood later in the season. The use of arsenical poisons has not proved effective in the control of the carrot rust fly. This is probably owing to the relatively short interval that elapses between the emergence of the fly and the time that egg laying normally begins. In the final analysis the control of the carrot rust fly on celery lies largely in keeping the celery crop as far removed from carrots as possible.

[5] CROSBY, C. R., and CHUPP, CHARLES. Cornell Extension Bulletin No. 206, New York State College of Agriculture, Ithaca, N. Y., February 1934.

BLANCHING

Originally most of the celery grown for the market in the United States was blanched by being banked with soil. This method required planting in rows 3½ to 4½ feet apart, in order to provide sufficient soil with which to bank the plants. Later the growers turned very largely to close planting and the use of boards for blanching, but with the gradual increase in the cost of lumber, strips of specially prepared paper have largely replaced the boards. Within the past 4 or 5 years the improvement of the so-called self-blanching and special strains of celery have made it possible to avoid very largely the use of boards, paper, or any other material for blanching. Under present cultural methods these self-blanching varieties are planted close

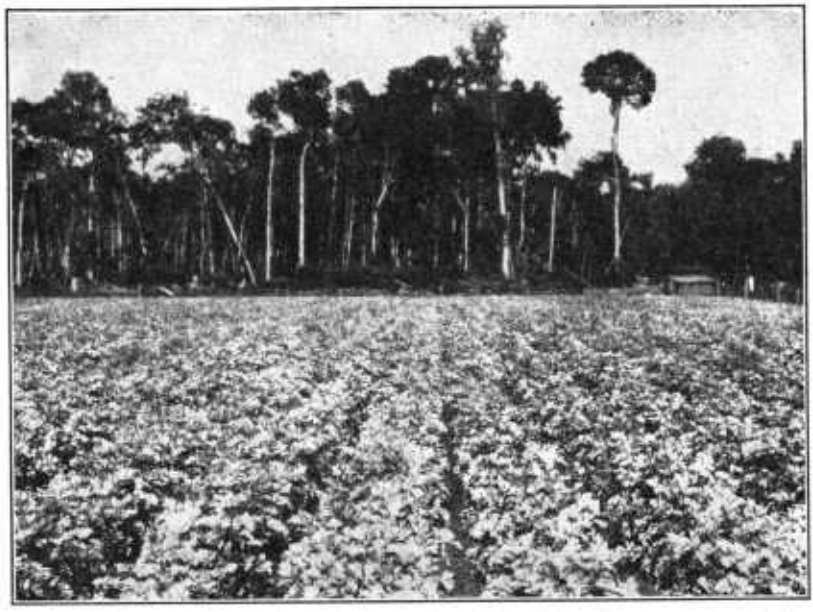


FIGURE 16.—Florida celery field showing close spacing of rows. Timber in the background shows the condition of the land before it was cleared for growing celery.

enough (fig. 16) so that the celery foliage will largely exclude the light and cause the stems to blanch sufficiently to meet market requirements. This is especially true of the so-called early celery crop marketed direct from the field and not stored. Celery that is to be placed in storage should be reasonably well blanched before it is packed in the crates, as the blanching process proceeds very slowly under the low temperature of the storage houses.

More complete blanching of the stems can be accomplished by planting the celery in rows from 24 to 34 inches apart, then, after it has reached about three-fourths of its maximum growth, strips of paper (fig. 17) are placed alongside the rows. The paper is held in place by wire spanners that straddle the rows and are set in the ground a sufficient depth to hold the paper. Various types of machines have been developed for unrolling the paper and applying it to the rows. One such machine is shown in figure 18. At the end of the blanching

FIGURE 17.—Strips of special paper being used for blanching celery.

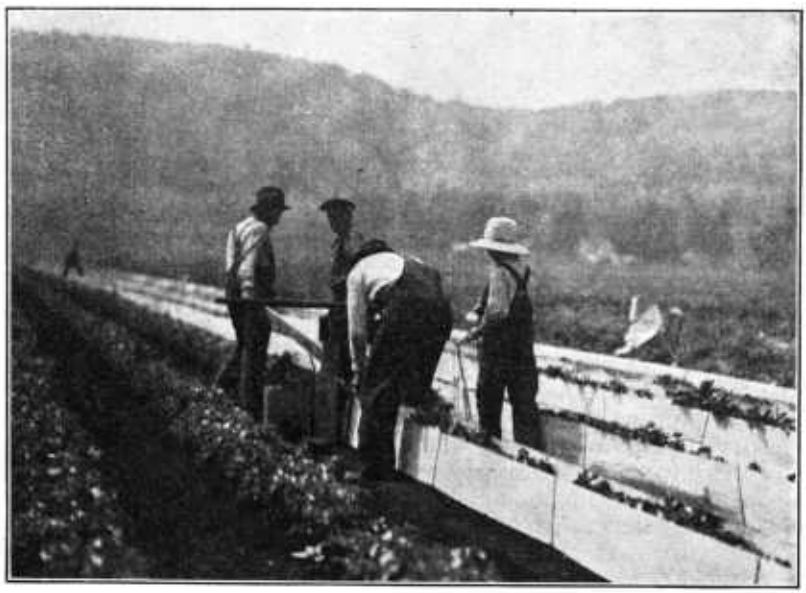


FIGURE 18.—Device used for applying paper to rows of celery.

period the machine is reversed in direction, and by means of two cranks the paper is rerolled and stored, or it may be rolled up in one section of the field and transferred to another, to be used a second or a third time during a single season. There are several firms manufacturing special celery-blanching paper. To be serviceable, the paper must be waterproof and of sufficient strength to stand handling. Certain manufacturers run lines of stitching lengthwise through the paper to give it strength, especially near the edges.

Many celery growers in the Great Lakes area still have on hand a supply of 1-inch boards 10 or 12 inches in width with which to blanch their celery crop. The boards are hauled into the celery field on high-wheeled wagons that will straddle one row of celery. After the boards are distributed they are placed alongside the rows and held in place by wire spanners which clamp across at the top from one board to another. In a few instances the boards are held in place by stakes, but the wire spanners are much more economical both as to cost and handling. The time the celery has to remain in the paper or the boards is from about 10 days to 2 weeks, but it is necessary to market or store the celery immediately after it is taken out of the paper or boards. One objection to the use of boards is their cost; another is the labor required for handling them and changing them to another section of the field. For these and other reasons the paper is now preferred by most celery growers.

Considerable celery of the Giant Pascal and other green types grown in the vicinity of the large eastern cities and marketed locally is still blanched with soil. It is thought by many growers and consumers that the banking method gives celery of higher quality than when it is blanched either by means of paper or boards. A large amount of labor is involved in the banking; however, by the use of horse-drawn banking machines such as that shown in figure 19, the cost can be reduced to a minimum. When boards are used for blanching, a celery hiller is frequently run through the rows after the boards are in place, in order to bank a little soil against the lower edges of the boards and close any openings.

When celery is grown on clay loam or any soil that is likely to be more or less lumpy there is danger of injuring the stems in the process of banking with earth. On muck and sandy loam soils there is little difficulty from this source. In order to bank the celery without the hearts becoming filled with the soil it is often necessary first to draw the stems together by hand in a compact bunch and to pack a little soil around the base of each plant to hold the stems together. By means of a celery-banking machine the soil can then be worked around the plants without any great danger of its getting into the hearts. The heart portion of a celery plant lengthens during the bleaching process, and any clods or rough particles of soil getting into it would interfere with its development.

A process of blanching celery with ethylene gas has recently been developed. Experiments have shown that while the use of this gas will destroy the coloring matter in the celery and give a white appearance, this method of blanching does not yield the quality found in a good grade of celery that is blanched either by means of paper, boards, or especially by banking. The use of ethylene gas is sometimes resorted to where storage celery requires additional blanching before being

placed on the market; however, its commercial value for blanching celery has not as yet been fully demonstrated.

Where a small quantity of early celery is grown in the home garden the blanching may be done by placing 10- or 12-inch boards along both sides of the rows and holding them in place by stakes driven into the ground. Another method is to cut sections of wrapping paper and wrap each stalk of celery separately, leaving the tops exposed above the paper wrapping. The paper can be held around the bunches of celery by rubber bands or short pieces of string. The late crop of celery in the home garden may be banked with earth, or it may be boarded for a time and then placed in a trench, as discussed later under the storage of celery. The blanching process will be completed in the storage trench during the storage period. When the celery is stored in a cool cellar with its roots embedded in moist soil, the light may be cut off by darkening the cellar windows, and the celery will blanch to a snowy whiteness. If the light is completely excluded, however, the product is likely to lack the true celery flavor.

FIGURE 19.—Field of celery in the process of blanching by means of boards. A celery hiller in the foreground.

HARVESTING

Early varieties of celery, such as Golden Plume, Early Fortune, or Wonderful, have a tendency to become overripe and pithy if held too long. Marketing arrangements should always be made in advance so that the celery may be moved in time to avoid this stage of overripeness. The greater part of the early crop is trimmed and packed in crates in the field, and the final trimming and washing are done by the dealers at its destination. In some cases the early celery is handled through a packing house, where it is given its final trimming. It is then washed and precooled before being placed in the crates for shipment. This is especially true in Florida, where a large part of the crop is handled during the warm weather of early spring. If the

celery is not shipped promptly when it has reached maturity it becomes more or less pithy and loses weight and flavor.

The first step in harvesting celery is to remove the blanching paper or boards; then a cutter or digger is run underneath the rows of plants to loosen them. Two types of diggers are in use, one designed to be drawn by a team or tractor and the other to be pushed by hand. The hand diggers consist of a pair of light wheels, a framework to which a cutting blade is attached, and a pair of plow handles. The diggers designed to be pulled by a team or tractor usually consist of a pair of wheels and a tongue, as shown in figure 20; or a cutting blade is attached to the wheels, and the running gear of a light wagon and suitable levers for regulating its depth are provided. If a tractor is used to draw the celery cutter it must be of a very high wheeled type

FIGURE 20.—Cutting device used for loosening the celery.

in order to straddle the rows of celery. The draft of these diggers is comparatively light, and a lightweight team can handle them without any difficulty. An experienced operator soon learns to regulate the depth of the cutting blade by the sound it makes in cutting off the roots of the celery. Following the cutter, the men or women who do the trimming lift the celery, shake off the remaining soil, and strip the plants of their outer leaves and leaf stems, as shown in figure 21. If too much of the root has been left on the plants by the digger, the trimmers remove this excess with knives. As the plants are trimmed they are placed in piles ready to be packed in crates.

Late celery, to be held in storage under refrigeration, is usually packed in the field, as shown in figure 22, and the crates are nailed, loaded on wagons or trucks, and hauled directly to the storage house. Celery to be stored in trenches in the field or in local farm storage houses without refrigeration is trimmed very little except that the outer leaf stems are removed. In the storage trenches or in the house

the roots are bedded to some degree in soil or at least are stood upon a bed of loose, moist soil which furnishes a certain amount of moisture to the plants, especially during the early part of the storage period.

FIGURE 21.—Stripping the outer leaves from celery after it has been dug and before it is packed in the crates.

Harvesting celery on a large scale is usually done in an organized way. As a rule two or three men precede the cutter and remove the boards or blanching paper. They are followed by the cutter; then

FIGURE 22.—Packing celery in crates in the field.

a crew of four or five men or women do the trimming. Two men will be required for packing the celery in the crates and one man for nailing on the tops. This will make a crew of about 12 or 13 persons in addition to the drivers who haul the celery from the fields. Under

favorable conditions a good working crew of this size will cut and pack 800 to 1,000 large or 1,500 small crates of celery a day. Exposure of the celery to the sun and wind after it is dug and trimmed should always be avoided, and it should be crated and removed to the car or the storage house as promptly as possible. Celery that is to be washed and packed in a central packing house is usually placed in field crates that are emptied at the packing house and returned to the field.

PACKING AND SHIPPING

The greater part of the commercial celery crop does not enter storage but is shipped direct to the markets. The celery is packed either in crates in the field, as already noted, and hauled directly to the cars, or is transferred to a central packing house, where it is washed and precooled before being packed in the crates and loaded. In California the celery crop is practically all field-packed and loaded directly into the cars, but it is frequently precooled after it is loaded and before being shipped. A portion of the California crop is shipped in crates that are 22 by 20¾ by 24 inches in size, 180 of these crates being loaded in a standard refrigerator car. The remainder of the California crop is shipped in what are termed one-half crates, which are 11 by 20¾ by 22 inches and load 360 to the car. Celery growers in New York and Ohio ship largely in what is termed a two-thirds crate, which is 22 by 16 by 20¾ inches and loads 240 to 250 to a car. Michigan celery growers ship in a variety of crates including a two-thirds crate, 22 by 16 by 22 inches, a one-half crate, 24 by 15 by 15 inches, another one-half crate, 24 by 10 by 20 inches, and still another crate known as a "highball", one size of which measures 18 by 15 by 15 inches and the other 18 by 10 by 10 inches. For the various crates used in Michigan the loading range is from 255 for the two-thirds crates to 825 for the small highballs. New Jersey and Pennsylvania growers use the more or less standardized two-thirds crate, the dimensions of which are 22 by 16 by 20¾ inches. They load 240 to 250 to a car.

Various sizes and styles of crates are used for shipping the closely trimmed, washed, and bunched celery. In many cases these crates are more in the nature of boxes, as they almost completely enclose the celery. Parchment paper is being used extensively for lining the crates in which fancy washed celery is handled, and the Kalamazoo, Mich., growers have for several years been handling celery put up in bunches of 1 dozen each and wrapped in thin or semitransparent parchment paper.

When celery is shipped during the winter the cars are usually lined with heavy building paper to protect the celery against freezing in transit. On the other hand, celery that is shipped during warm weather must be fully iced, and the best results have been obtained where the load was precooled before it started. Crates used for shipping celery by express during the winter are heavily lined with parchment or other strong paper before being packed, and in addition the outsides of the crates are frequently covered with heavy wrapping paper to prevent the celery's freezing during loading and unloading or while in transit.

STORAGE

Considerable of the late celery crop grown in the northeastern area is stored for marketing during the late fall and early winter. Two methods are employed, the cold-storage method, by which the celery

can be held from 2 to 4 months, and the trench method, which is more or less temporary and designed to hold the celery for a few weeks at most. The storing of celery under refrigeration has within the past 15 or 20 years become important. The storage chambers are usually constructed of brick or hollow tile insulated with cork and cooled directly by refrigeration. These storage chambers are usually built 6 to 10 in a unit, and each of the chambers is about 32 feet in width, 60 to 80 feet in length, and 14 feet in height. A receiving platform is constructed across one end, at which the trucks or wagons coming from the farms can unload. At the opposite end there is usually a railroad siding for convenience in loading the celery into the cars. Large doors are provided at both ends of each chamber.

As the crates of celery are received from the farms they are trucked into the storage chambers and stacked practically to the ceiling with 1- by 3-inch strips between the layers of crates to hold them steady and provide circulation of air between them. Aside from a narrow space which is left around the outer walls and, in some instances, a narrow passage through the center, the crates of celery are stacked practically in a solid block. A temperature of between 33° and 34° F. is maintained about 6 feet from the floor. Under normal conditions the temperature will be slightly higher near the ceiling of the storage chambers. As the crates of celery are brought from the farms and put into the refrigeration chambers they contain considerable heat, and as this is given off it frequently forms pockets of warm air. To overcome this difficulty, fans have been installed in some of the houses to stir the air and secure more uniform refrigeration. Celery in storage freezes at a temperature of 29.86° F. (practically 30°), and care must be taken that the temperature near the floor of the storage chambers is not as low as this.

In years past, special storage cellars and houses without refrigeration have been used extensively in the northern sections for holding celery for the holiday and early winter trade. These storage cellars or houses are constructed with earth floors 1 to 2 feet below the general level of the surrounding ground, with concrete or brick walls, and a heavy double roof with plenty of ventilators. Doors are provided in each end of the house; in some cases these doors are large enough for a truck or a team to be driven directly through the house to unload the celery as it comes from the fields. Owing to the fact that this type of storage is dependent entirely upon the natural temperature of the air to keep it cool, careful management of the ventilation is required in order to have the celery keep. However, the management of these cellars or storage houses is similar to that of natural-temperature apple-storage houses, cold air being admitted at night and during periods of cool weather and the houses kept fairly tightly closed during warmer periods.

The greater part of the late celery crop grown in the northeastern sections, especially through Ohio, New York, Pennsylvania, and New Jersey, is held in trenches in the fields where it is grown. In most cases the trenches are dug with spades and are 14 to 18 inches wide and deep enough so that when the celery is placed in them the tops will be about 2 or 3 inches above the original level of the soil, or a broad, flat trench about 3 feet in width is opened with a turnplow and a special trench-opening device similar in construction to a snowplow. After a wide double furrow has been plowed out, the special trenching

device is drawn through the bottom of the double furrow, thus opening the space for the packing of the celery in the trench. When this method of opening the trench is followed the celery is packed in a strip about 3 feet wide, and the soil is banked up against it on the outside.

Under the trench method of storage the celery is lifted and rough-trimmed, and considerable of the root is left on it. It is then carried in armfuls to the nearby trenches and laid in bundles alongside the trench. The man who places the celery in the trench wears rather high boots or leather leggings and stands in the trench with his back to the stored celery. The stalks of celery are taken singly and are placed in the trench in an upright position back of the operator's feet. This is accomplished by a sort of swinging motion of the hands; at the same time first one foot and then the other is lifted and slightly moved to one side, then the stalk of celery is pressed into position by a backward movement of the foot. In this way the celery is packed close together in the trench.

When the trenches are first filled, the tops of the celery are left exposed, but as the weather becomes colder two 10-inch or 12-inch boards are placed over the trench in the shape of a letter A, and soil is banked over the boards to keep out the cold. When the 3-foot trench is employed, strips of roofing paper are used as a covering, the edges of the paper being held in place by banking soil over them. In all cases the trenches containing the celery must be given a reasonable amount of ventilation and the celery kept just as cool as possible without actually freezing. The trench method is perhaps the best for the storage of the home supply of celery throughout the northeastern part of the country, as the ordinary house cellar is too warm and not sufficiently well ventilated. Many gardeners who have 200 to 500 bunches of celery to store for home use clean out the pit of their hotbed and store their supply of celery in it, using boards as a covering rather than sash. This system works very well, especially on farms where a supply of corn fodder, straw, or other similar material is available for covering the hotbed after the weather becomes cold. In all cases proper ventilation is necessary.

GROWING CELERY SEED FOR PLANTING

Prior to about 1915 the greater part of the celery seed handled by the seedsmen of this country was grown in Europe, especially in France and Italy. Previous to that time small amounts of seed had been grown in this country, but, with the interruption of the seed business abroad incident to the World War, American seedsmen and seed growers began to pay more attention to the production of celery seed in this country. As a result of this activity marked changes and improvements in varieties were made, and the production of high-grade celery seed became well established in both the Eastern and Western States. The methods followed by the American growers have been more thorough than those of European growers, with the result that a better grade and quality of seed has been made available to celery growers.

The highest-quality celery seed grown in this country is produced from plants that are specially selected for conformity to variety and type at the time the crop is being harvested in the fall. In addition to the careful selection that is made in the fall, all offtype plants are

removed from the seed plots during the spring and before the seed matures. The plants that are selected for seed production are carried through the winter in coldframes, as shown in figure 23, or they are planted directly in the seed plots, where they are heavily mulched to prevent their being killed during the winter. Those planted in the coldframes are set 12 to 15 inches apart, and the frames are covered with sash, the sash being raised for ventilation at all times except when the weather is several degrees below freezing. The soil in which the seed plants are set is fertilized with phosphoric acid and a small amount of potash. In the spring the plants are cultivated, and the seedstalks are tied to stakes.

As a rule the plants that are to produce seeds are planted where they can be irrigated, if necessary, as a reasonable degree of moisture

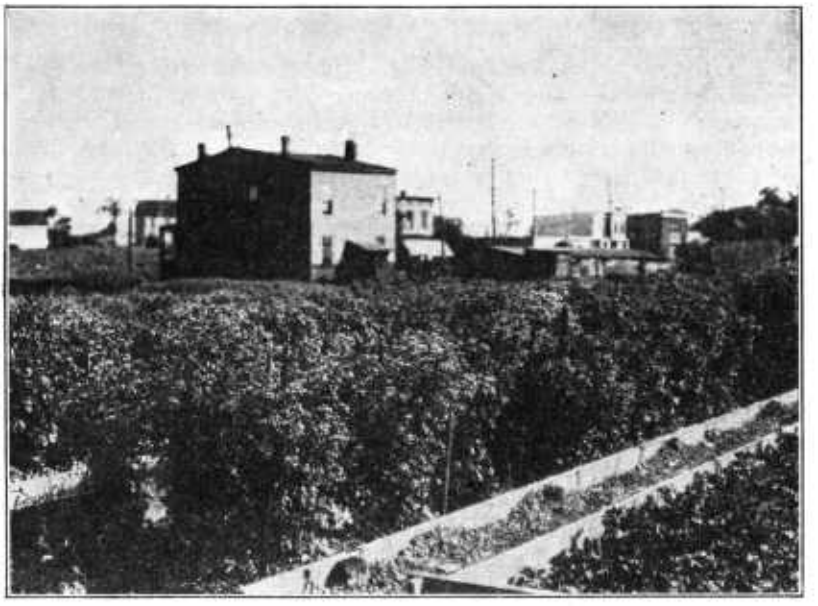


FIGURE 23.—Celery seed being matured in coldframes.

in the soil is essential to the production of a full crop of plump seed. Clean culture is practiced, and when the seed has passed the dough stage the heads are cut with 12 to 15 inches of stem, tied in bunches, and hung head downward in the upper portion of a barn or building where they can be given plenty of ventilation and partially protected from the light. Handled in this manner, the seeds will ripen in good shape and may be kept until time for threshing and cleaning. Hung in this manner, the seed heads will shatter very little; in some cases the seed is not threshed and cleaned for 6 months to a year.

The growing of celery seed is a 2-year proposition, the stock plants being grown the first season and the seed produced the second season. For this reason it is necessary to have two lots of seed plants under cultivation each year—the stock plants and the seeders. This, however, does not mean any overlapping, except that seed grown the previous year must always be provided for growing the stock plants. The commercial growing of celery seed is now so well established in

the United States that the celery grower has only to select his special variety and seed stock and then make the necessary arrangements with a dealer who has seed to sell. The fall testing of the celery seed and carrying a supply over from one year to another is highly desirable, although many of the seedsmen are protecting their customers by keeping a carry-over supply on hand. Celery seed does not begin to lose its germinating power for 3 or 4 years if kept dry and under reasonably uniform temperature.

U. S. GOVERNMENT PRINTING OFFICE: 1944

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 5 cents